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MOTORS AS DISTINGUISHED FROM DYNAMOS.

In the early days when the modern type of motor was introduced it was generally believed that radical differences existed between dynamos and motors, and that a machine designed for one purpose would not fulfill all the requirements of the other. It was not, we believe, until Hopkinson pointed out early in 1887 that the same machine when used as either a dynamo or motor ran at practically the same efficiency and had about the same sparking tendency, that modern views were accepted. More careful study later on revealed the relative effects produced by armature reaction, self-induction and eddy currents and their action in dynamos and motors respectively. While in most designs of direct-current machines the knowledge of these effects has not resulted in the introduction of any radical differences between dynamos and motors, so that a machine designed as a dynamo may be used equally well as a motor, yet slight differences exist in several respects, especially in the matter of regulation. When a shunt machine is run as a dynamo the field may be either strengthened or weakened by varying the resistance of the field circuit, but when run as a motor the field strength cannot be conveniently increased beyond the point for which it is designed, so that the insertion of a resistance in the field circuit has the one effect of causing the motor to speed up. The regulation of a dynamo may be effected easily, whereas in a motor it is quite difficult, the methods at present in vogue being inefficient and, unless applied for a special purpose, unsatisfactory. In the two machines the relative effects of armature reaction, self-induction and eddy currents are quite opposite; whereas in a dynamo armature reaction has a tendency to weaken the field, very objectionable with heavy loads, the same effect in a motor increases the field strength, thereby producing a positive advantage, inasmuch as it tends to maintain the speed constant with increasing load. The effect of self-induction in a dynamo is to require a larger shifting of the brushes for sparkless running than in a motor; at the same time this effect tends to diminish the impressed E. M. F. of the former, while increasing the counter E. M. F. of the latter. Eddy or Foucault currents like armature reaction tend to strengthen the motor field but weaken the field of the dynamo. In an article by Mr. Wiener, concluded in this issue, the author discusses the calculation of electric motors and the considerations which tend to distinguish such calculations from those applicable to dynamos. As will be seen, the chief distinction lies in the fact that, given a dynamo driven at a predetermined speed, to calculate its E. M. F. and output, while a motor, supplied with a given potential difference at its brushes is required to develop a given output at the required speed. This article, we believe, will be found of considerable service to those interested in the design and calculation of electric motors.

SHUNT MOTORS IN RAILWAY PRACTICE.

The introduction of direct-current shunt motors on several European railways within the past few months has doubtless called the attention of many to the early but futile attempts made in this line. The chief causes for this result have been due to the difficulty of controlling a shunt motor for various speeds without introducing the complications of commutating the field, also the evil effects produced by the discharge of the field brought about by imperfect contact between wheels and rails, or the jumping of the trolley. In motors of

the same output the cost of construction of the shunt type is necessarily greater, due to the increased field copper required and the necessity for better insulation. The evils brought about by the breaking of the main circuit, thereby allowing the field to discharge and causing an excessive armature current upon re-closing the circuit, could be easily overcome by the employment of a magnetic device which would practically ensure full field strength before the armature receives current. The successful variable mechanical gear for street-car work has apparently not made its appearance, but if such could be obtained the advantages derived by employing a constantly running shunt motor would be many. The output of a motor, when running under this condition, would be considerably less to do the same work of existing apparatus, while the efficiency would be higher and the depreciation materially diminished. In an article which appears in other columns of this issue, Mr. Baxter points out several advantages which the shunt motor possesses, as compared with the series type, and also shows the conditions which make its successful operation possible. The advantages may be summarized as follows: A shunt motor having a commutated field may be made to restore energy to the line when descending a grade or when its speed is being reduced. The former feature would result in producing a more uniform potential along the feeders, would reduce the line copper, the station load, and therefore both the first cost and cost in operation, while the latter would diminish the wear on the brakes and brake-shoes. At the same time a more uniform starting and variation of speed than that obtained by the series-parallel method could be produced, while at each speed any given torque could be obtained. The speed could be made less dependent upon the voltage than by existing methods, so that within limits any desired speed could be maintained at the most distant part of the line while the efficiency at low speeds would be greater. Shunt-wound motors for railway service have up to the present failed in obtaining a foothold in this country, apparently because of the evil effects of the accidental opening of the field circuit, the better insulation required, the increased cost of construction necessitated by commutated fields, the non-successful variable gear, the necessity of maintaining a field current under all conditions prior to the closing of the armature circuit and the tendency of a shunt motor without commutated field to run at constant velocity. As summed up by Mr. Baxter, the shunt motor possesses many distinct advantages over the series motor and it remains to overcome but a few of the difficulties to make its operation as reliable and efficient.

PAPERS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The papers read before the meeting of the American Society of Mechanical Engineers, held in New York City last week, were, as usual, large in number and of excellent quality, not a few being of importance from an electrical standpoint. The governing of steam engines, dating from the early conception of Watt, has been more successfully accomplished perhaps, than any other single improvement in the steam engine practice, notwithstanding the fact that the old type of governor still remains the leading type on large units. In a paper presented by Mr. Ball on "Steam Engine Governors," the author discusses the underlying principles of fly-wheel governors and the essential features of their operation. Although, as pointed out in the paper, the utilization of accelerating forces other than centrifugal forces was taken up as early as 1875, it has only been during the past four or five years that the principle has been appreciated and applied to the governing of steam engines. Previous to this time many had used the force of acceleration combined with a centrifugal force, but apparently unconsciously, as many governors were so constructed as to have the two actions working in opposition, thus causing the engine to hunt. Centrifugal force, constant as long as the speed is constant, is the more utilized and important, while the accelerating force, the force due to the variation in the engine speed, when taken advantage of, results in the production of a most sensitive and powerful governor. These forces are opposed by springs, the tension of which is constant as long as the speed is constant, and the pull of the valve and friction of the moving parts which are variable factors of incalculable effect. A careful study of the above principles has resulted in the production of governors guaranteed to regulate within 1 per cent. between no load and full load, and at the same time has enabled a comparatively wide range of cut-off to be used without contracting the port openings and therefore obviating the attendant losses due to wire drawing, a fact of especial importance in single-valve engines. In a paper on "The 'Promise and Potency' of High Pressure Steam," Prof. Thurston points out the advantages of adiabatic expansion to be obtained more approximately than at present by increasing both the steam pressure and the ratio of expansion as much as possible, conditions which, however, are limited by heat radiation, back pressure, friction, first cost and other considerations. The results of tests made on a quadruple expansion engine show a consumption of 9¾ pounds of steam per indicated hp-hour when developing about 15 horse-power at 400 pounds gauge pressure. Still better results, Prof. Thurston believes, can be obtained by effective super-heating, excellent design, construction, management, and by the elimination of initial condensation. He considers it not unreasonable to expect an economy when the demand for heat is about 6000 B. T. U. per indicated hp-hour, of eight pounds of water when working under a pressure of 1000 pounds. The attainment of these figures means the overcoming of many severe difficulties, and will be therefore the result of a gradual development. Another paper of value to power users is that presented by Mr. Benjamin on the "Friction Horse Power in Factories." The paper gives the results of tests made in 16 different factories devoted to the manufacture of various lines of machinery, and contains tables showing the total available horse-power and the relative amounts required to drive the machines and shafting. The average conditions showed that the percentage of power to drive shafting was above 50, that in six cases it ran above 60 per cent., in one case was as high as 80 per cent., and with but a single exception which showed 14½ per cent. at one fourth load, the percentages were above 39. A careful inspection of the plant in which the lowest figure was obtained showed that the machinery was very compactly arranged, but otherwise the conditions were the same as in other shops. The shafting, however, had been constructed with great care, was in perfect alignment and ran in cast iron boxes without babbitt metal, was supported by unusually rigid hangers and was oiled by hand instead of by wick oilers. The results of these tests should call the attention of power users to the large proportion of power expended in the driving of extensive systems of shafting and to a consideration of the advantages to be derived by the use of electric motors in many cases.

Patent Office Statistics.

The report of the Commissioner of Patents upon the business of the Patent Office for the fiscal year ended June 30, 1896, shows that there were received within that year 41,660 applications for patents, 1641 applications for designs, 84 applications for reissues, 2460 caveats, 2064 applications for trade marks and 171 applications for labels. There were 22,791 patents granted, including reissues and designs; 1782 trade marks and 11 prints registered. The number of patents which expired was 11,466. The number of allowed applications which were by operation of law forfeited for non-payment of final fees was 4014. The total receipts were $1,307,090.30; the receipts over expenditures were $209,721.45, and the total receipts over expenditures to the credit of the Patent Office in the Treasury of the United States amounts to $4,776,479.18.

External Regulation of Alternating-Current Motors.

ALBERT G. DAVIS.

Devices for the speed regulation of alternating-current motors may be roughly divided into two classes: First, where the regulation is external, and, second, where it is internal. The first class comprises those arrangements in which the speed of the motor is controlled by changing the character of the current delivered, while in the second class the control is effected by changes in the connections or resistance of the motors themselves. The second class includes the series-multiple and tandem-multiple systems, of which the last is now beginning to attract attention; and also, among others, those devices in which changes in the induced winding furnish the means of control, the classical method of regulating induction motors. The present article deals with the first class only.

External regulation may be effected by changing (1) the frequency and (2) the voltage of the current supplied.

The change of frequency would furnish an ideal regulation if it could be effected without too great complication and loss, as the alternating-current motor tends to run at or nearly at synchronism with the current fed to it. But, unfortunately, this method involves either a commutator or a frequency changer, and the almost ideal simplicity of the induction motor is lost.

Prof. Rowland has described a very ingenious arrangement, making use of a commutator. A two-phase current is passed through a phasing transformer, an elaboration of that shown by Scott in his lecture before the National Electric Light Association in 1894, and split up into a current of many phases. Each secondary lead is connected to a segment of a commutator, on which there are as many brushes

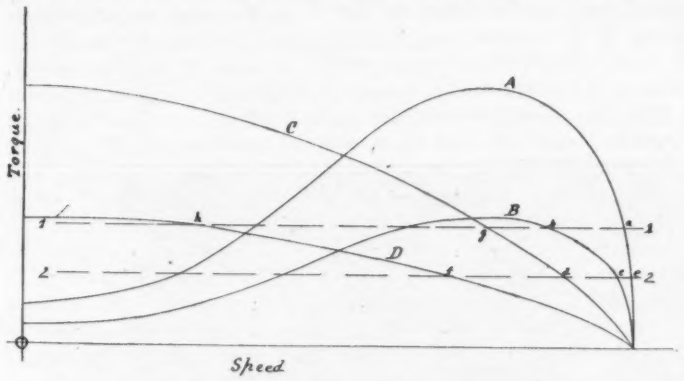


FIG. 1.—TORQUE CURVES OF AN INDUCTION MOTOR.

as there are segments. If now these brushes remain fixed with reference to the commutator, they will take off a current of a frequency equal to that impressed on the system. If they revolve in the proper direction at a speed corresponding to synchronism they will take off a current of zero frequency, that is to say a direct current. If they revolve at any other speed the resulting current will be, in general, of a frequency different from that supplied. By properly operating the apparatus a motor may be started with full torque, and run at any speed desired.

Various types of frequency-changers have been proposed and patented. The writer invented, a year or so ago, a frequency-changer without moving parts, but soon became convinced that it was inoperative. A few months later the same device was patented in England. The fact is, a frequency-changer without moving parts is like a coil-wound unipolar generator, a physical impossibility, and is probably destined to attract nearly as much attention as that historic affair, and perhaps to uselessly consume as much labor and time.

But frequency-changers, whether with or without commutators, cannot as yet be said to be commercial successes, and their interest is at present mainly theoretical, though it must be remembered that in this art the theory of to-day may be the common practice of to-morrow. Various forms have been invented by Bradley, Berg, Gutmann, and perhaps others, but, as far as the writer knows, nothing of the sort is on the market, or likely to be very soon. We will therefore pass to the second class mentioned above.

This class comprises arrangements for regulating the current, or the voltage of the current, supplied to the motors. This system is very useful in direct-current work, as is well known, but of course fails utterly on synchronous alternating machines. It was at first thought that it would also fail on synchronous induction motors, but a study of the curves shown in Fig. 1 shows that this is not the case. *A* is the torque curve of an induction motor with a low resistance secondary, on a constant-potential multiphase circuit. *B* is the same curve at a lower voltage. *C* and *D* are corresponding curves with a higher resistance secondary.

Suppose the torque required of the motor in a particular situation to be expressed by the distance of the line 1—1 from the horizontal axis. Then at the higher voltage the motor will run at the speed corresponding to the intersection *a*. Lower the voltage, and the

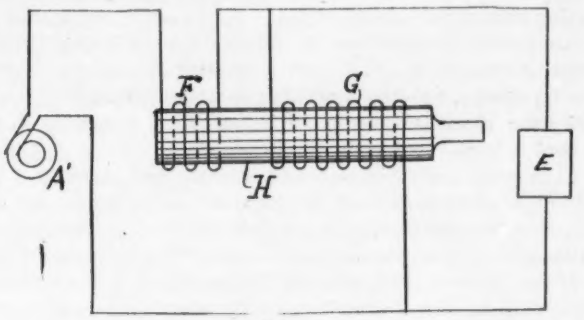


FIG. 2.

speed will drop to *b*. But if the voltage is lowered much further, the motor will stop running, and an examination of the curves will show that the amount of regulation obtained is small. But with the high-resistance secondary the corresponding points are *g* and *h*, giving a wide regulation. *e*, *c*, *d* and *f* are the corresponding points at the lower torque 2—2. It is thus evident that with a sufficiently high resistance in the secondary, it is possible to vary the speed between wide limits, by merely varying the impressed E. M. F. This method involves great losses as the efficiency of the induction motor is always lower than the ratio of its actual speed to its "theoretical" speed, and also because a high-resistance secondary is required, but nevertheless it is simple and effective, and is at present the most practical solution of the problem which has been presented, with the possible exception of the old and well-known method, which consists in varying the resistance of the induced member.

The question then arises, how best to vary the E. M. F. impressed on an alternating translating device. The nature of the alternating current allows many solutions of the problem, nearly all of which are less wasteful than the insertion of a dead resistance. Some early work in this line was done by Elihu Thomson, who announced in 1887 and 1888, and at later dates, various devices for changing the voltage of the secondary of a transformer, by moving the core in and out of the coils, by placing a short-circuited damping coil over the core, by changing the distance between the primary and secondary coils, etc. Gutmann, C. E. L. Brown, Arnold, and Shallenberger have subdivided the secondary of the ordinary transformer, and by means of a switch supplied the translating device with a higher or lower voltage as required. A similar application has been made of the auto-converter.

Rice, in 1892, interposed in the three leads of a three-phase system three choke coils, and moved the damping circuits of the

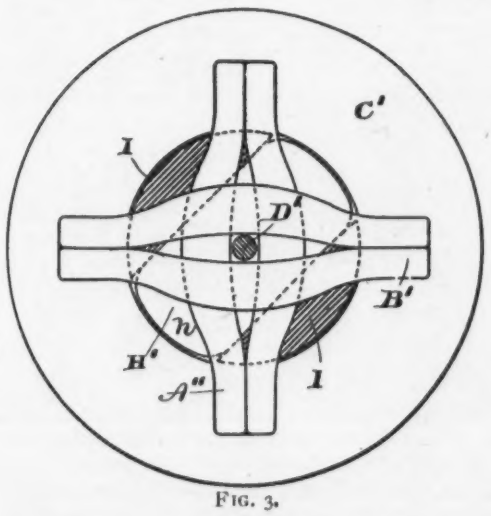


FIG. 3.

three choke coils simultaneously by a single bar, and at about the same time Thomson applied the principle of the Ayrton and Perry sechometer to the same purpose. He mounted a movable coil inside of a stationary one and connected the two in series or in multiple. By turning the inner coil so that the mutual induction was a maxi-

mum, he was able to choke down the current considerably, while if the two coils stood at right angles the current was able to pass freely. For multiphase work several of the regulators were used, with their movable coils mechanically connected together.

The General Electric Company has lately perfected a line of regulators which have proved very effective in practice. They are based on an invention of Belfield, patented in 1888, of which the principle is illustrated in Fig. 2. *A* is the generator and *E* the translating device to be regulated. A series coil *F* and a shunt coil *G* are wound on the same core *H*. If the core is drawn out of the series coil the full E. M. F. of the generator is impressed on the translating device, but in the position shown the lines of force generated by the shunt-coil set up in the series coil a counter E. M. F. which chokes back the current.

It will be seen that this principle, which runs through a whole series of regulators, consists in placing one coil in series and one in shunt, and using the lines of force induced by the shunt coil to set up in the series coil an E M. F. which performs the desired regulation. If one of the coils is reversed the apparatus will evidently act as a booster. In fact, it is strictly analogous to the booster system in direct-current work, in which a motor in multiple drives a generator in series with the feeder.

With this broad idea as a basis, various interesting and practical devices have been worked out, principally by Steinmetz and Armstrong. One of the simplest is that used by the Carborundum Company. Imagine an ordinary alternating motor, with its armature held so that it cannot rotate, but so arranged that it can be adjusted by a system of gears such as is used to adjust the brushes of an ordinary direct-current generator of the multipolar type. One of the windings is in series with the mains, and is of course wound with heavy wire, while the other winding is in shunt. If the armature is rotated by the gears so that the mutual induction is zero, there is no effect whatever, and only a very small current will pass through the shunt coil.

If now the armature be rotated a few degrees in one direction the device will act just as does the regulator shown in Fig. 2 and cut down the E. M. F. The energy consumed in this way is returned by the shunt coil, which acts as a generating coil. If the rotation be in the opposite direction the shunt coil takes current and acts as the primary of a transformer, whose secondary is in series with the generator and the E. M. F. is raised. The amount of the regulation will depend on the windings and on the angle at which the coils happen to be set.

Another regulator on a similar principle was invented by Steinmetz, and is shown in Fig. 3. *A''* and *B'* are the two coils, one in series and one in shunt as before, set in the laminated stator *C'*. *D'* is the shaft carrying the laminated mass *H'*. If this mass be set in the place of one of the coils the mutual induction is zero, but in

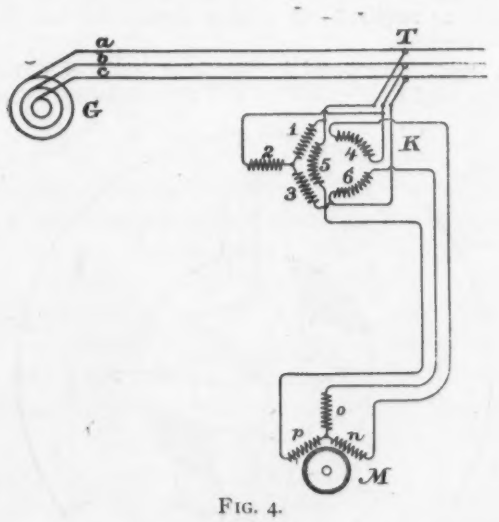


Fig. 4.

the position shown the lines of force from one coil pass through the other, and there is a boosting action. If the mass be set at an angle to the coils, but in a different direction, that is to say, 90 degrees from where it now is, the action will be to cut down the E. M. F. Copper masses *I*, I_1 prevent leakage of the lines of force and help the action. This device evidently bears the same relation to that just described as an inductor alternator does to the usual type of generator.

A very neat device due to Armstrong has just been patented which serves the same purpose as those just described, though it acts in a different way. It is illustrated in diagram in Fig. 4. *G* is the generator, and *K* the controller, supposed to be on a railway car. *M* is the motor to be regulated. The coils 1, 2 and 3 are in multiple with the line, in a star connection, while the coils 4, 5 and 6 are in series with the motor. It will be seen that the coils 1, 2, 3 act as the primaries of a transformer, and the coils 4, 5, 6 act as secondaries. The result is to impress on the motor the two E. M. Fs., that of the generator and that of the transformer, in series. But one set of coils is rotatable, and is fastened to a lever like the

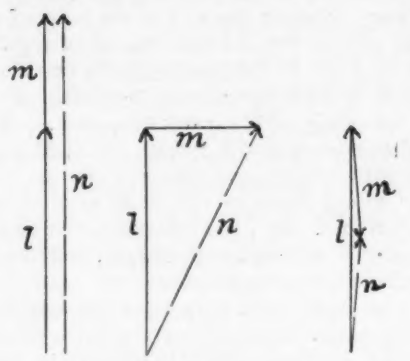


Fig. 5.

valve lever of a locomotive engine. It is therefore possible to change the phase relation of the two E. M. Fs. from coincidence to opposition. The three diagrams in Fig. 5 show what the result will be. *l* is the E. M. F. of the generator, *m* that of the transformer, supposed in this case to be one half as large, and *n* is the resultant E. M. F. impressed on the motors. In the first case the two E. M. Fs. are in phase with each other, and the resultant is a maximum, in phase with both. In the second case they are at 90 degrees, and the resultant is the square root of the sum of their squares, out of phase with both. And in the third case the transformer E. M. F., *m*, is nearly 180 degrees from *l*, and the resultant, *n*, is therefore only about one half of the E. M. F. of the generator. There is in this system no loss of energy excepting, of course, the $C^2 R$ losses, etc., in the transformer, and the principle is exceedingly ingenious. In practice, of course, the coils are wound on iron, and the regulator when finished looks like an alternating-current motor with a lever attached to its rotor.

New York & Haiti Cable Company.

At midnight on Dec. 1 the submarine cable between New York City and Haiti was opened to the public for the transmission of messages. The cable comes into New York *via* Coney Island and Brooklyn, and the company's main office is at 1 Broad Street.

This cable is the one involved in the suit brought by the United States Attorney-General, who sought to obtain an injunction restraining the New York & Haiti Cable Company, *et al.*, from landing its cable on American shores, on the ground that it was a cloak for the operations of a foreign corporation. Arguments on the application were heard by Judge Lacombe in the United States Circuit Court on Nov. 14 last, the judge reserving decision.

Judge Lacombe's decision has not yet been rendered, and, unrestricted, the cable company has accomplished its purpose. The history of the case will be found in The Electrical World of Oct. 10, and a *résumé* of the arguments for and against the injunction asked for given in the issue of Nov 21.

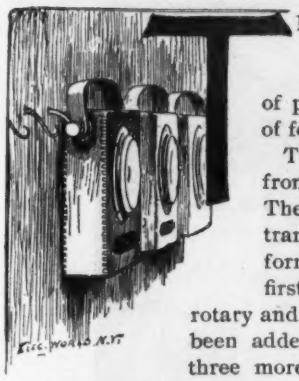
Meeting of the Institute.

At the 111th meeting of the American Institute of Electrical Engineers, which will be held at 12 West Thirty-first Street, New York, on Wednesday evening, Dec. 16, a topical discussion will be held devoted to a consideration of the relation of the Röntgen ray to physics. The discussion will be opened by Prof. H. A. Rowland and Prof. Elihu Thomson. Dr. M. I. Pupin, Dr. A. E. Kennelly and others have signified their intention of participating in the discussion.

Niagara Power Transmission Up to Date.—IV.

BY FRANK C. PERKINS.

CURRENT FOR THE PITTSBURG REDUCTION COMPANY.



THE original installation of rotary and static transformers for the Pittsburg Reduction Company for the purpose of producing the metal aluminum consisted of four rotary and eight static transformers. These machines received their current from the Niagara Falls Power Company. The illustration shows the four 500-hp rotary transformers and eight 250-hp static transformers as originally installed. Since the first installation was completed, a fifth rotary and two additional static transformers have been added, with additional space provided for three more 500-hp rotaries and six more static transformers. The current is a two-phase alternating current which is conducted to the transformer house through an underground subway large enough for a person to walk through. It extends from the man-hole opposite the aluminum works to the transformer house of the Niagara Falls Power Company.

The transformer room is 87 feet long and 50 feet wide and the cables and conductors are all carried underneath the floor.

The last rotary transformer installed may be seen in the illustration as well as the switchboards for both the alternating and direct current distribution. The capacity is 600 kilowatts at 160 volts, the speed is 188 r. p. m., and a current of 3700 amperes is delivered to the bus bars. From the subway the current is received as a two-phase alternating current at 2200 volts, is then transformed to a low voltage and conducted to the rotary transformers, where it is changed from a two-phase alternating current to a continuous current of about 160 volts, which is best adapted to the production of aluminum. The capacity of the direct cables is enormous, as very heavy currents are used in the process. The carbon lined pots are arranged in series and connected to the electrical terminals. Copper rods are connected to the main line and then attached to heavy carbon cylinders or rods which act as anodes; the pots themselves with their lining are connected to the other side of the line, the current depositing the aluminum upon the bottoms of the bowl or pots, which act as cathodes. The metal is dipped out of the pots daily, and in its place is added more of the mixture to be reduced. The alumina is dissolved in a bath of molten fluoride of aluminum and fluoride of calcium or fluoride of sodium.

The operation is a continuous one, and the current is used day and night for months and months without interruption except by accident, or replacing pots which, however, last a considerable length of time. Each pot requires from four to six volts, so that a large number may be connected in series upon a 160 or 280 volt circuit.

The high-tension cables are lead-covered, and are 1.75 inches in diameter, outside measure. Each cable has a cross-section of 950,000 circular mils. The main cables are laid in a subway. Connected to these cables are four sets of cables, two in multiple, lead-covered and ⅜ inch in diameter made up of strands of No. 17 wire. These cables are connected to the static transformers by the switchboard shown in the illustration. The static transformers reduce the 2200-volt current to 115 volts and after passing through the rotary transformers the 160-volt direct current is delivered to the bus bars through the switchboard shown in the illustration. The bus bars, it will be noted, are very heavy and are of copper. In the new plant the bus bars in the aluminum works and conductors leading to them are of aluminum.

The cables connecting the low-tension secondary of the static transformers to the lower part of the alternating switchboard are of 1,500,000 circular mils cross-section. It is necessary to maintain a blast of air through the static transformers in order to dissipate the heat, and this is done by means of the centrifugal blowers operated by electric motors seen in illustration. The efficiency of the static transformers is very high, being 98 per cent.

The enormous demand created for aluminum has made it necessary for the company to increase its capacity for turning out the metal. The new works just completed and now in operation is located on the property of the Niagara Falls Power Company, on top of the high bank of the Niagara River below the Falls. The new building is very large, covering two acres of land and gives employment to a large force of men, both day and night. This plant is now in perfect

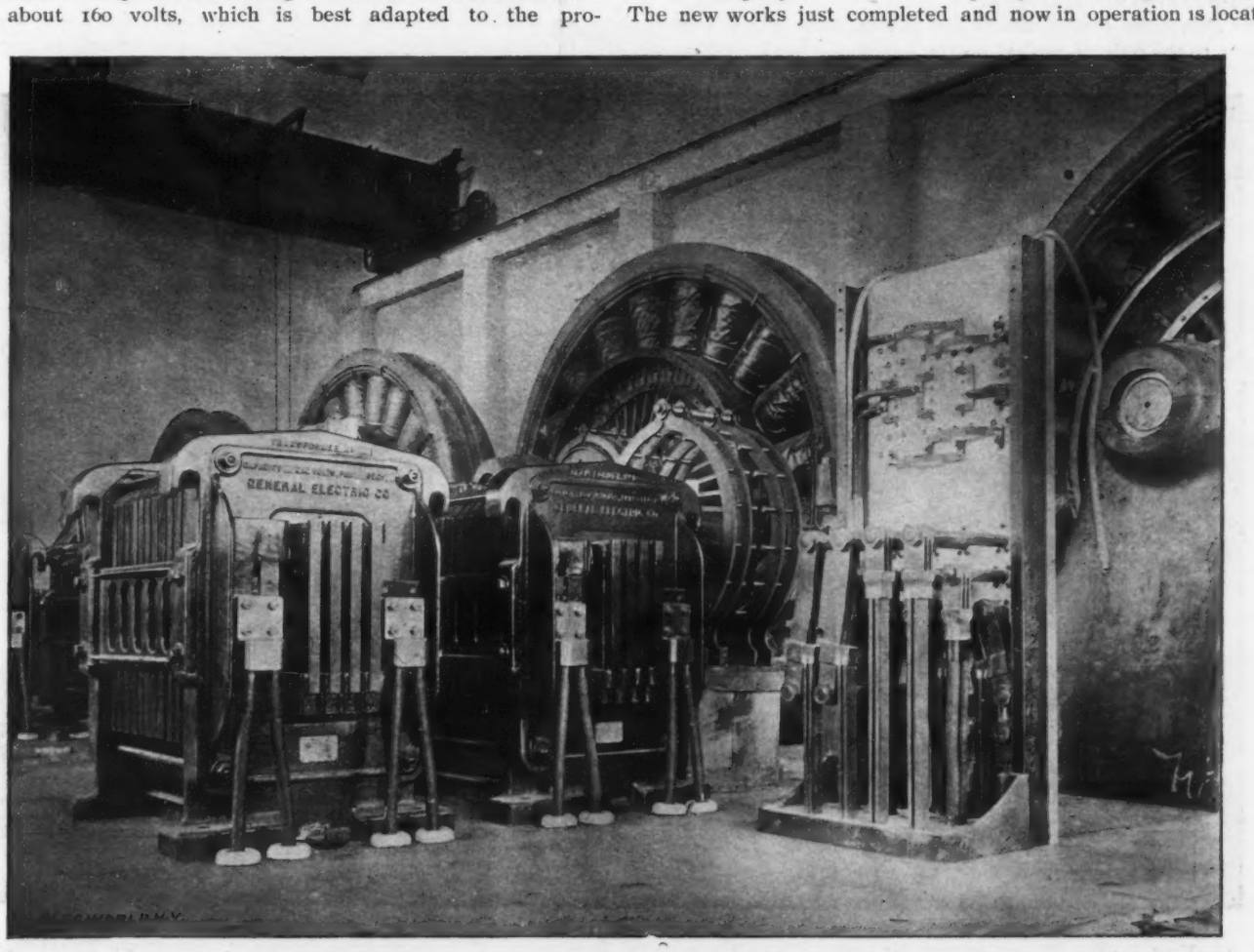


Fig. 1.—FIRST INSTALLATION OF PITTSLURG REDUCTION COMPANY—FOUR ROTARY TRANSFORMERS, 115 VOLTS ALTERNATING TO 160 VOLTS—DIRECT CURRENT. TWO-STATIC TRANSFORMERS, 2000 115 VOLTS—INSULATING PORCELAIN TUBES.

operation and plans have been made for doubling its present capacity. In the power-house is now installed 4500 horse-power, available in dynamos of which they are now using 3000 horse-power. This is all direct-current machinery and the power is transmitted to the

FIG. 2.—8000-AMPERE COPPER BUS BARS. 250 ⅜-INCH ALUMINUM CONDUCTORS IN DISTANCE.

FIG. 3.—ALUMINUM CONDUCTORS AND ONE OF THE 560-KW. 280-VOLT GENERATORS.

plant where it is used in the form in which it is generated. In this respect this plant differs from others using the power of the Niagara Falls Power Company, where the current is received in the form of a high-potential direct current.

The aluminum conductors in the power house which convey the current to the reduction plant on the top of the bank each consist of bundles of 250 three-eighths inch aluminum rods. The weight of aluminum required for this purpose is little less than half that of copper rods of an equivalent carrying capacity. Recent experiments have shown that ordinary commercially pure aluminum has from 64 to 65 per cent. of the conductivity of copper and very pure grades of aluminum are said to run as high as 70 per cent.

At the present price at which aluminum is sold in large quantities it is just about equivalent to copper for the purpose of electrical conductors. The conducting line in the upper plant is built of bars 12 inches deep and 1 inch thick.

It has been found by experience with the old plant where aluminum conductors have been used for several months that it answers equally as well as copper. The joints, of which there are a number in the line, do not heat and the line gives no trouble in any way. The

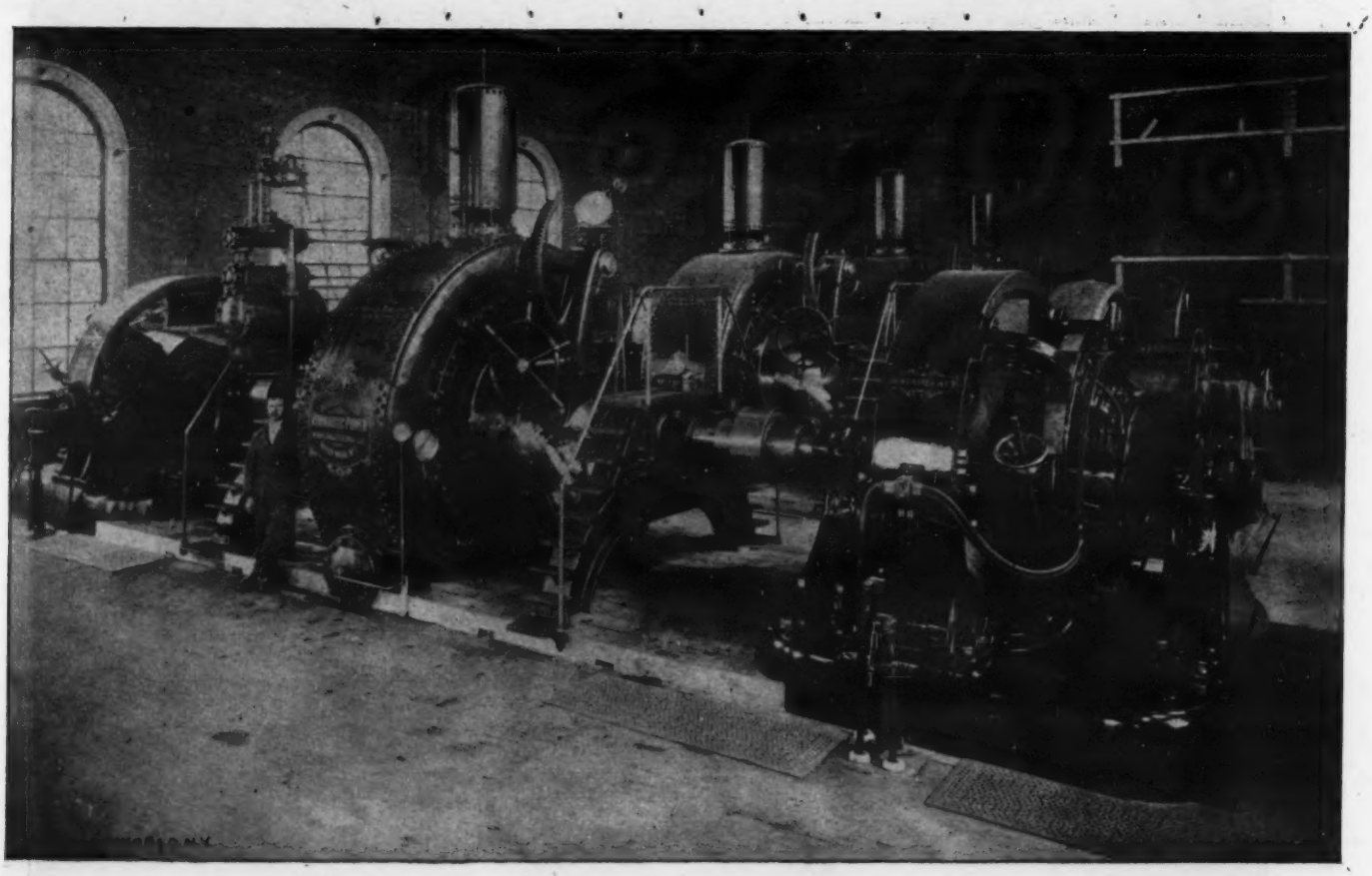


FIG. 4.—NEW POWER PLANT OF THE NIAGARA FALLS HYDRAULIC POWER & MANUFACTURING COMPANY, SHOWING TURBINES, GOVERNOR AND STREET RAILWAY GENERATORS.

output with the new plant together with plant already in use will be about 10,000 pounds of aluminum per day and this amount can readily be increased from machinery already in place.

The output per day will seem enormous when it is known that the total

output of aluminum in the United States for the six years from 1883 to 1888 was only about 40,000 pounds or four days' product of the present works. In 1883 only 83 pounds were produced ; 1884, 150 pounds; 1885, 263 pounds ; 1886, 3000 pounds ; 1887, 18,000 pounds; 1888, 19,000 pounds. The present plant will produce at the rate given by Mr. Hall 3,650,000 pounds per year or 10 times the amount produced in the United States in 1893 and seven times the total product of the United States in 1894, which was 550,000 pounds.

The two bundles of aluminum conductors mentioned above may be seen in one of the accompanying illustrations with their connections to the main copper bus bars in the power house of the Niagara Falls Hydraulic Power & Manufacturing Company.

The current for the Pittsburg Reduction Company in the new works is supplied from Westinghouse Electric & Manufacturing Company's generators, shown in illustration. There are in all six eight-pole generators delivering a direct current to the bus bars at 280 volts. The six machines may run in parallel, delivering 2000 amperes each at 280 volts. The two Westinghouse machines, having a capacity of 750 horse-power, or 560 kilowatts, are directly connected by flexible spring couplings to a Leffel water turbine generating 2000 horse-power.

There are three Leffel wheels so connected generating electric power for the aluminum works. The copper bus-bars shown in illustration are 10 inches high and ¾ inch thick, and to each of these bus-bars are attached the 250 aluminum wires No. 00, which are painted with black insulating paint and carried through wooden conduits up to the aluminum works, as shown in illustration. Six Weston ammeters indicate the current flowing, each reading to 2500 amperes. These instruments are all of the type having illuminated dials, and a single Weston voltmeter is used, indicating as high as 600 volts. The Pittsburg Reduction Company also has a plant in operation at New Kensington, Pa., which is operated by steam power.

This plant is a model steam plant, and is using coal costing 60 to 70 cents per ton delivered to the works. Thus, Niagara power is considered cheaper than steam power under the most favorable circumstances.

NEW APPARATUS OF THE PITTSBURG REDUCTION COMPANY.

FIG. 5.—DIRECT-CURRENT SIDE OF ROTARY TRANSFORMER. 600 KW. 188 RVS. 160 VOLTS.

FIG. 6.—HIGH TENSION ALTERNATING CURRENT SWITCHBOARD.

FIG. 7.—BLOWERS FOR COOLING 2000-VOLT STATIC TRANSFORMERS.

FIG. 8.—TWO-PHASE ALTERNATING SIDE OF ROTARY TRANSFORMER.

FIG. 9.—DIRECT-CURRENT SWITCHBOARD AND BUS BARS FOR LATEST ROTARY TRANSFORMERS.

THE NIAGARA FALLS HYDRAULIC POWER & MANUFACTURING COMPANY'S NEW PLANT.

The Niagara Falls Hydraulic Power & Manufacturing Company, the rival of the Niagara Falls Power Company, is now ready to furnish 40,000 horse-power.

The opening of the rival company's plant was witnessed by the most prominent citizens of Niagara Falls and Buffalo. The party from Buffalo went to the Falls on the new and superb drawing-room car now in use on the Buffalo & Niagara Falls Electric Railway. The company is now furnishing over 8000 horse-power. The enlargement of the hydraulic canal, cut through solid rock, has been completed and 40,000 horse-power under a head of from 100 to 200 feet is available for use, and it is believed that this power will be constant and reliable in every way. The writer's attention was called to the latest development of using power under a head of 210 feet.

The company is at present furnishing current for the Lewiston & Youngstown Electric Railway, the Pittsburg Reduction Company, and Niagara Falls & Lewiston Electric Road, known as the Great Gorge Road, and several mills and factories.

The Gorge Road is equipped with cars of the J. G. Brill Company and has a very fine equipment throughout. Capt. J. M Brinker, of Buffalo, is president, and J. K. Brooks, superintendent. The Gorge Road was constructed with great difficulty and gives a most excellent view of the Falls and Whirlpool Rapids. The grades on this road are quite heavy. From the cantilever bridge there is a 5 per cent. grade for several hundred feet, then for about a half a mile the grade drops to 4 per cent., then for about 1000 feet reaches as high as 6 per cent. The power for this road as well as that of the Lewiston & Youngstown, is supplied from the new power-house of the Niagara Falls Hydraulic Power & Manufacturing Company on the river bank. The Lewiston & Youngstown Road is about seven and one half miles long, and is equipped with 68-pound rails. The cars are of the J. G. Brill Company's make and are equipped each with two General Electric motors. The road will also have an electric locomotive with a four-motor equipment, one attached to each axle of the car.

The F. W. Oliver Company, of Niagara Falls, furnished the electrical equipment for the road. The trolley wire is a No. 00 and the current is supplied by the Hydraulic Power Company by a cable which feeds into a No. 0000 feeder at Lewiston. This feeder continues a half mile and the trolley wire carries the entire current from that point on to Youngstown. The current is supplied to the electric railways from the two 750-hp General Electric generators at the power-house aided by a 75-kw General Electric booster, which is a series-machine carrying 300 amperes at 250 volts, at 750 r. p. m. The two large generators are of the six-pole multiple type delivering each 560 kilowatts at 550 volts, operating at 300 r. p. m. These machines are capable of carrying an overload of 50 per cent., without injury. The booster at 250 volts raises the voltage from 550 volts on the generator to 800 volts on the main feeder to the railway lines. The two generators are rigidly connected to a Leffel turbine, one being on each side. The turbine makes 300 r. p. m. and is regulated by a special Lombard water wheel governor shown in the illustration. This governor regulates within 1 per cent., the load varying at times from zero load to 300 horse-power. This governor was specially constructed for this particular case. The Leffel wheel it governs generates 1900 to 2000 horse-power under a head of from 210 to 217 feet. Water is used in this regulator instead of oil. The oil under pressure is usually supplied by a special oil pump for operating the governor, but in this case water from the penstock is used at a pressure of 85 pounds. The speed balls on the top of the governor operate the upper valve with any variation in speed. The governor has an appliance by which the governing machine is checked before it has carried the gate too far open or shut, thus preventing racing.

It may be of interest to note that the work on the canal of the Niagara Falls Hydraulic Power & Manufacturing Company was commenced in 1892, the old canal being widened to 70 feet and being made 14 feet deep. The canal now has a capacity of 3000 cubic feet per second and will develop an increased horse-power of about 40,000 over its former capacity.

The water for the new power house is taken from the basin to a forebay 30 feet wide and 22 feet deep located on the edge of a high bank. From the forebay, penstock pipes of flanged steel, eight feet in diameter, conduct the water 210 feet to the power house at the edge of the river below the Falls. The power house is 180 feet long, and will contain eventually 16 wheels of about 2000 horse-power each. The building will be extended in width as the demand for power increases. The wheels work under a head of 210 feet, the highest head thus far used for such a large power. Owing to the fluctuation of the height of the water in the lower river, which is as much as 30 feet, it was deemed advisable to place the generator floor of the station some 20 feet above the normal water level, and in order to connect the water wheels directly to the generator shafts it was necessary to have them at the same elevation. Draft tubes were necessitated in order to utilize the full head available. A turbine wheel mounted on horizontal axes was the only type which would give the necessary speed regulation, and at the same time be direct-connected. The penstock runs down vertically 135 feet, thence down a slope to the station, next to the bank, and is there eight feet in diameter connected with a 10-foot pipe running horizontally along the centre of the tail-race. Valves are placed in each five-foot connection to each wheel, so that one wheel may be shut down independently of the others. The wheels are of 1900 horse-power and run at 300 revolutions per minute. The following is a description of the Leffel wheels supplied by James Leffel & Co., Springfield, O., four of which are at present installed.

The wheel runners, in case of three wheels which are to run the generators of the Pittsburg Reduction Company, and which are to run at a speed of 250 revolutions per minute, are 78 inches in diameter; in case of the other wheels, which are to run at 300 revolutions per minute, 66 inches, the size being calculated so that a point in the periphery of the runner will move at a speed equal to about 75 per cent. of the theoretical velocity of water due to the head under which the wheels are operating.

The rim of the runner is the bucket ring, and is cast solid from gun-metal bronze. On this rim are two sets of buckets taking water on face and discharging at each side of the rim. The bucket ring is bolted to the spokes of the cast-iron centre, the hub of which is keyed to the shaft of hammered iron 20 feet in length.

Surrounding the outside of the runner is a cylinder in which the gates are fitted. The gates are about 20 per cent. less in number than the buckets. They are hung on steel pins and open by lifting one edge so that the direction in which the water enters the wheel is nearly tangential to the runner.

Each gate has two arms which are connected to the rings by means of which they are opened and closed.

This work is enclosed in a cylindrical case 11 feet in diameter and 4 feet long, which is connected to the penstock by a supply pipe 5 feet in diameter.

On the side of this case elbows are fitted, to which the draft tubes are connected. The shaft passes out through these elbows through stuffing boxes. On the inside of these elbows lignum-vitæ steps are fastened, against which rings on the shaft work to prevent end motion on the shaft.

To each end of the water-wheel shaft will be rigidly coupled a direct-current generator capable of developing 560 kilowatts of electrical energy.

The beams upon which the wheels stand are extended through underneath the generators; the whole are fastened together and bolted firmly to the masonry foundations.

The plant was installed substantially as specified by Engineer W. C. Johnson, and its success, as viewed at the opening this month, has been largely due to his energetic work.

The Recent Coast Storm.

The hurricane of Wednesday night, Dec. 2, was considered the worst experienced in the vicinity of Norfolk, Va., for many years. The telegraph and telephone companies suffered more than at any previous time, there being some 350 poles blown down and the sea-coast telegraph service entirely demolished.

Shunt Motors for Railway Work.

BY WM. BAXTER, JR.

No doubt every American engineer who has been engaged in the work of designing railway machinery has at some time given more or less thought to the question of using shunt motors, but the very fact that such machines are not in use is an indication that they have not been looked upon with favor. The first impression would undoubtedly be that motors of this type, on account of their running at a nearly constant velocity, could not meet the requirements of railway work, but a more thorough investigation of the subject will lead to the conviction that such a conclusion is not tenable.

The ordinary type of shunt motor, used for stationary work, would not be suitable for the propulsion of cars, but by means of a few slight modifications it can be made to meet all the requirements. This conclusion must have been arrived at by the Siemens & Halske Company, of Berlin, for it is reported that they have installed motors of this type in several instances during the past few months.

It may probably occur to many that the reduction of such a system to an operative form is a new achievement, and they may wonder why it should have been accomplished in Europe instead of this country, where we are so far in the lead in the railway field. The Europeans can, no doubt, claim the distinction of being the first to give the shunt-motor a practical test, but it is very doubtful whether they were the first to develop a system of this type that would work successfully. The writer designed such a system about five years ago, and it is more than probable that several other engineers in this country have done as much.

The salient objections to the shunt-motor are that the shunt-coils cannot be made as substantial as the coils of a series-machine, and

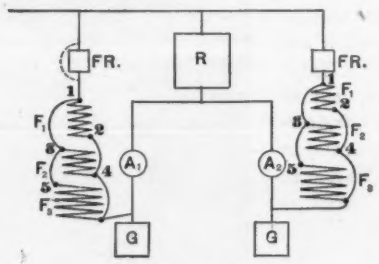


FIG. 1.

further, that the space required for them is considerably greater, but this last feature, while a serious matter in the early days of the electric railway, when the space allotted to the motors was small, is of little moment at the present time when the restrictions in size do not in the least hamper the designer. Perhaps the greatest objection, however, is the greater cost of construction.

The advantages of shunt motors are quite numerous; they can recover energy in going down hill and also in stopping or reducing speed and by this very act can reduce the wear on the wheels, as the retardation of the velocity can be effected without using the brake. They can also be arranged so as to give a greater variation in speed, and, what is of considerable importance, any given torque can be obtained at several different velocities, which is not the case with series-motors. The electrical efficiency at low speeds can be made higher and this added to the fact that a certain amount of energy can be recovered in stopping and descending hills, would reduce the average current consumption and thus reduce the station capacity and the wire in the line.

Another important advantage is that the speed can be increased or decreased without respect to the voltage, therefore the velocity at the end of the line can be equal to that at the point nearest to the station. The amount of energy that can be recovered by the use of shunt motor is wholly an indeterminate quantity; we can easily calculate the theoretical value of the source from which the recovery is made for any particular case, but as to the percentage of this that could be utilized nothing definite can be said, since the amount will vary with the variations in velocity.

The recoverable energy is that developed by the motors, when the counter E. M. F. rises above the impressed E. M. F., over the amount necessary to overcome the friction and head resistance, and as this latter amount is very nearly constant at all speeds attained in practice, it follows that if, in going down hill or in making a stop, the retardation opposed to gravity, or to the momentum of the mass is small, the energy developed by the motors in the form of electric current may be but a trifle in excess of that required to overcome

this resistance. On the other hand, a sudden stop may throw a considerable current back on the line. It is evident therefore that we can only assume a saving but cannot determine how much it would amount to, since on the same road it would not be the same for any two trips.

If the motors were so constructed that the ampere-turns around the field could not be changed, no energy could be recovered in stopping or reducing the speed on a level track, since the counter E. M. F. under such conditions could never rise above the direct E. M. F. In running down hill under the same conditions a given percentage of the energy developed by the descent could be recovered, but this percentage as well as the velocity of the car would be dependent

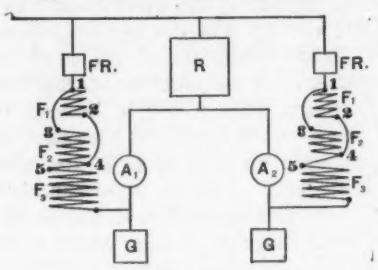


FIG. 2.

upon the inclination of the track, and would not be controllable. Inasmuch as the cars are frequently stopped, or slowed down, it is desirable to have them so constructed that at such times some energy may be recovered. In descending grades it is necessary that the velocity be under the control of the motorman, and as these conditions cannot be fulfilled with a simple shunt winding, a modification of the system becomes necessary. It is true that by the use of the brake the speed down grades as well as the retardation in slowing down or stopping can be regulated, but under such conditions little or no energy would be recovered, and the system would have one less advantage over the series-motor to compensate for its manifest disadvantages.

To render it possible to recover energy in stopping, the field coils must be made so that the magnetizing force may be changed at will, in order that the counter E. M. F. may be raised above the direct E. M. F. by increasing the flux and without an increase of speed. By this same expedient the velocity on descents can be varied to suit the requirements, and the speed at the end of the line can be maintained just as high as at any other point.

There are several ways in which the strength of the field may be varied, but they all involve some arrangement of commutating the coils. Two methods are shown in the five small diagrams, the first three figures representing one and the last two the other. In the latter arrangement the shunt coils of both motors are connected with the line in parallel for a strong field, and in series with each other for a weak field. The magnetic flux can be still further reduced by cutting in more or less of the resistance of the rheostat *F R*. The objection to this method is that it can only be used with two

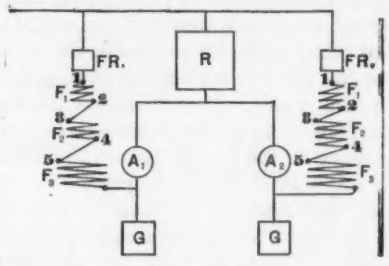


FIG. 3

motor equipments, and furthermore, in such cases, if one of the fields should become grounded the car would be rendered nearly helpless, as it could only proceed under one speed, so far as the field winding is concerned, although by the aid of the rheostat this could be considerably modified.

The arrangement shown in Figs. 1, 2, 3, is the better of the two, as it can be used with either one or more motors. In this method the two armatures are connected in parallel, and in series with one starting rheostat. The field of each motor is divided into three sections, and these are connected in series or parallel as shown in the figures to obtain different strengths of field. In the first figure, which shows the connection for the strongest field, the sections are in parallel and the rheostat *F R* is cut out. In Fig. 2, sections 1 and 2 are in parallel, and in series with section 3, and in Fig. 3, the sections are all in series. In this way three gradations of the field strength can be obtained by the commutation of the coils, and further reductions of strength by cutting into the circuit sections of the rheostat *F R*.

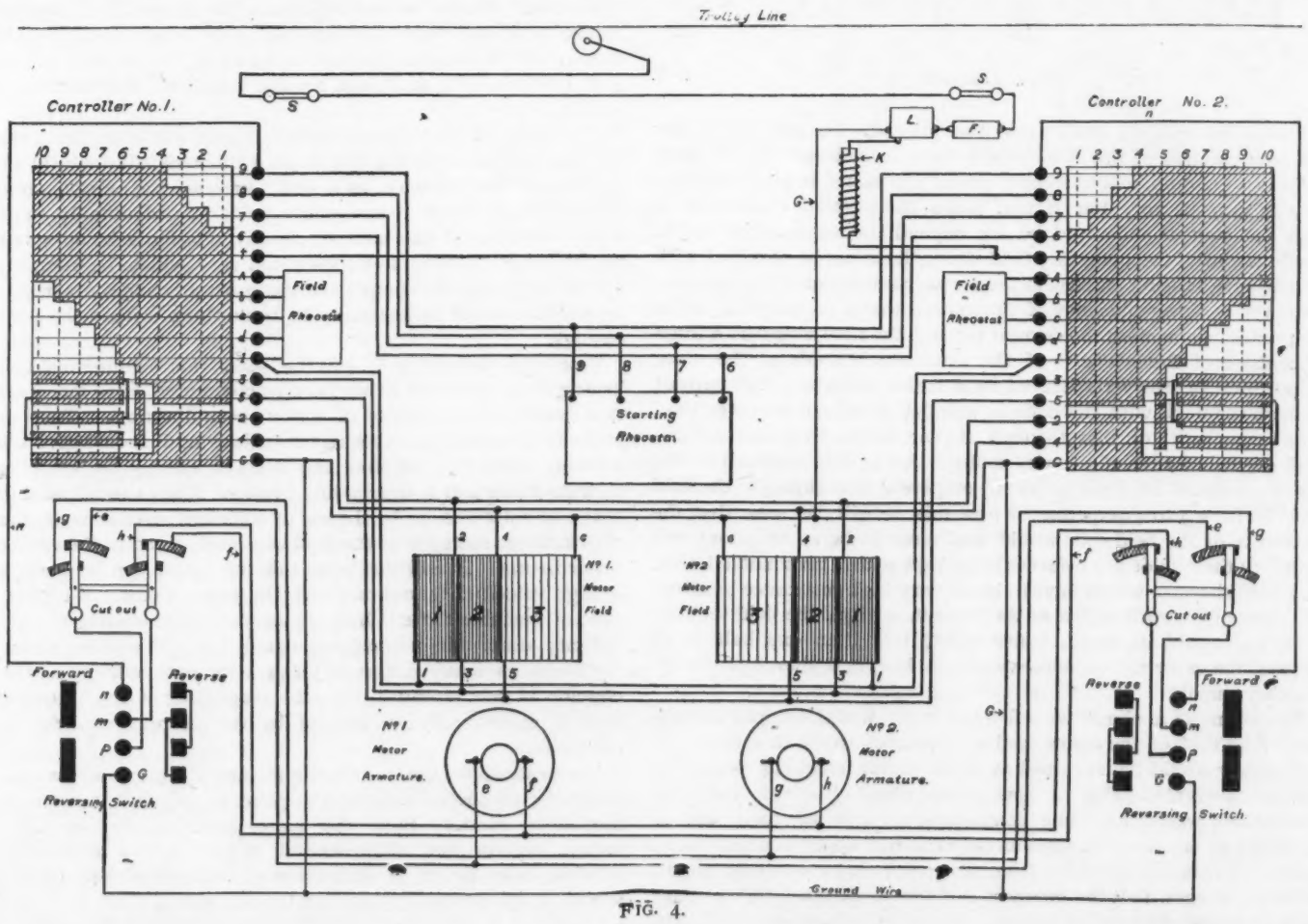
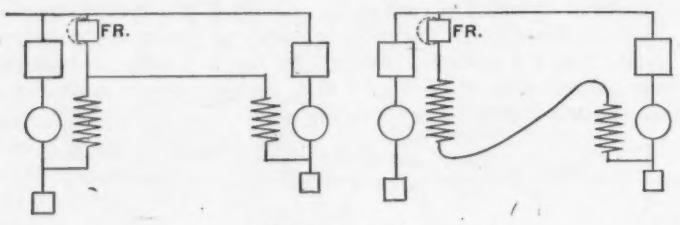


FIG. 4.

As will be noticed, the section 3 is shown much larger than the others, the object of this being to obtain a more nearly equal increase of magnetizing force in passing from one combination to the other. If the three sections were all of the same resistance and of the same number of turns, the increase between Fig. 1 and Fig. 2 would be very much greater than between 2 and 3, for, as will be seen, if the turns in each section are equal to *a*, the total ampere turns in the series connection would be equal to 3*a*, and with the first and second sections in parallel, as the resistance would be reduced to one half, the current would be doubled and the ampere turns in section 3 would be 2*a* and *a* in 1 and 2 respectively, making 4*a* for the three sections. With the sections all in parallel, the ampere turns of each would be 3*a*, as the resistance would be reduced the one third, and the total ampere turns would be 9*a*; hence the ratio of increase from one combination to the other would be as 3, 4, 9. By reducing the resistance of section 3 and at the same time increasing the number of turns, the ampere turns on the intermediate step can be made to come nearer to those of the first or parallel combination, and that is the reason why this section is so designed. By obtaining a proper relation between the resistance and number of turns of section 3, as compared with sections 1 and 2, the magnetizing force for the three combinations can be made to be in the relation of 1, 2, 3, but to accomplish this it would be necessary to increase the size of 3 beyond the limit allowable in practice. It is possible, however, without increasing section 3 unduly, to come very near to uniform increase of ampere turns.

From the foregoing it will be at once evident that the space required for the field coils in shunt wound railway motors would be much greater than in those of the stationary type, since each section would have to be of wire large enough to carry all the current that would flow through it when subject to the total difference of



Figs. 5 and 6.

potential between the trolley and the ground. In addition to this the cross section of the field would have to be larger than is used with series motors, so that when the coils are placed in series the flux density may be very low, if not, when the parallel connection is used the magnetism would be far beyond the economical limits. Furthermore, if the necessary field strength cannot be obtained with a small magnetizing current in the series connection of the coil sections, the working efficiency of the motors would be very low, as in the parallel connection the current through the field would be a large percentage of the whole. If the armature is made of the same proportions in every respect as in a series machine, the current through the field, with the coils in parallel, could not be more than 3½ or 4 per cent. of that through the armature, to obtain an efficiency equal to that of a series motor. As in this connection the armature would be from 40 to 50 amperes, that through the field could be from 3 to 4 amperes. From this it will be seen that the resistance of the field coils would not have to be so very low, and therefore the size of the coils could be kept within reasonable limits. The field rheostat would have to be of very high resistance to afford any range of variation, but as the current, with all the field sections in series, would be small, considerably less than one half of an ampere, the carrying capacity would be low, and therefore its dimensions small.

The wiring of a shunt wound equipment would be less complicated than that of the series, and the switches would be more durable, as they would be traversed at most of the breaking points by weaker currents. Fig. 4 gives an idea of what the wire connections would be. The controllers, as will be seen, are of the simplest construction, and as only the five upper contacts carry heavy currents, the sparking from that point down would be small, so small, in fact, that the contacts could be made much lighter than those now used with series motors. There would only be 10 wires in which the current would be as great as in the series system. In the other six the current would never rise above four amperes, therefore they could be made small enough to be bunched into one cable not much larger than the No. 6 cables used at the present time.

The course of the current through the controllers and reversing and cut-out switches would be as follows:

From the trolley line the current would pass to the two emergency switches *S S*, and thence to the fuse *F*, the lightning arrester *L*, the kicking coil *K*, and to the trolley contacts *T* of the controllers. If controller No. 1 were turned to the first step, and the reversing switch at that end were thrown to the forward position, the current from *T* would pass to 6, and then through the rheostat to 9, and wire *n* to contact *n* of the reversing switch. Here it would pass to contact *m*, to the right-hand cut-out, and by wires *e* and *g* to the left-hand brushes of both armatures. From the armatures the currents would return by the wires *h* and *f* to the left-hand cut-out, and thence to contact *p* of the reversing switch and from here to the ground. The movement of the controller over the next three steps would cut out the sections of the rheostat in succession. Up to the fourth step, it will be noticed, the terminals 1, 3, 5 and 2, 4 *G* of the field are connected with each other respectively, but in passing to the fifth step 5, 2, 4, are connected with each other, and so are 1 and 3, but *G* is disconnected. The current through the field with this connection of the terminals would be the same as in the small diagram, Fig. 2, where it will be seen that 1 and 3 are connected, and also 2, 4 and 5. This connection places sections 1 and 2 of the fields in parallel and in series with section 3.

In passing to the sixth step terminal 1 is disconnected from 3 and the latter is connected with 2, while 4 is connected with 5; thus the three sections of the field are placed in series, as in Fig. 3.

In passing to the steps beyond the sixth the sections of the field rheostat *F R* are cut in one at each step, and as the current through the contacts *b*, *c*, *d*, 1, would be less than half an ampere the spark would be hardly noticeable, therefore the movement of the switch handle for each one of these steps can be very much less than for the first ones, and this renders it possible to reduce the diameter of the cylinder, and as for the same reason the distance between the lower contacts can be made much less than for those above, the switch can be reduced in length as well as width.

By turning the cut-out switch either of the armatures can be disconnected. If it is turned to the left, the current will pass to *e* and return by *f*, and these are the terminals of the armature of No. 1 motor. If the cut-out is turned to the right, the current will pass to *g* and return by *h*, and these are the terminals of armature of No. 2 motor.

The fields, as here shown, cannot be cut out from the controller, but they can be so arranged if desired although it is doubtful whether this would be desirable, as it would increase the wiring complications. The best way to cut out the fields is, undoubtedly, to provide small switches at the side of the car, which can be operated from the outside. As these switches would very seldom be used, it would not be advisable to complicate the controller and the wiring to the extent that would be necessary to locate them within the controller casings.

From the foregoing it will be seen that shunt-wound motors arranged so that the fields may be commuted have many features that render them worthy of serious consideration. They can be made fully as efficient as series machines and should give a higher working efficiency, as they can recover energy in stopping and slowing down and in descending grades. They can afford a greater range of velocities, as by the use of sufficient resistance in the field rheostats the strength of the field can be changed in the ratio of five or six to one. In addition to all this the torque can be made higher at high velocities than it can with the series motor. With the latter type of machine there is but one torque corresponding to any given velocity, other things remaining equal, but with a shunt motor there would be as many different torques for each velocity as there are changes in field strength, and the magnitude of the torque at high speeds would only be limited by the current capacity of the armature.

Unquestionably the series motors are the more substantial, and, reliability of operation being the point of greatest importance, this fact alone renders them the more desirable, but as it is by no means certain that shunt-wound motors cannot be made just as reliable, time spent in endeavoring to remove their weak points would in all probability not be thrown away.

Tunnel Under the East River.

The New York State Railroad Commission will, on Dec. 15, give a public hearing on the proposal of the New York & Brooklyn Railroad Company to construct a tunnel under the East River.

Synchronous Motor as Compensator in Alternating-Current Distributions.

BY ERNST J. BERG.

(*Concluded from page 624.*)

Fig. 12 shows the proper synchronous motor capacity, and the saving by installing this motor. These curves are calculated with the same constants as have been used in the previous instances.

As seen, it will not pay to put in any synchronous motor when the factor is 85 per cent., or higher; however, the importance of installing the compensator is very apparent, the gain in dollars rapidly increasing even with very little drop in power factor. For instance, with a 75 per cent. power factor the proper synchronous motor should have a capacity of 55 kilowatts, and the gain in dollars per year, when the interest on the investment of the synchronous motor is paid, is as high as $210. With 50 per cent. power factor the size of synchronous motor should be 280 kilowatts, and the gain then, as compared with running a load having a 50 per cent. power-factor is $1240.

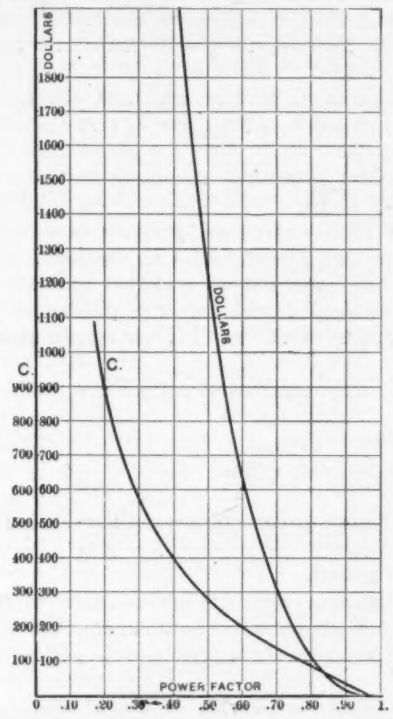


FIG. 12.—MOST ECONOMICAL SYNCHRONOUS MOTOR, AND SAVING, AT CONSTANT POWER, IN RECEIVING CIRCUIT.

Fig. 13 gives efficiency and power-factor curves of a plant with an 80 per cent. power-factor, before and after the most economical synchronous motor is used; gives curves when this synchronous motor is kept at constant field excitation, that is constant current, and when the excitation is changed with the load.

From these curves we find that the most economical synchronous motor has a capacity of 86 kilowatts; that is, 86 amperes at 1000 volts.

Without the synchronous motor the full load efficiency is 86 per cent., the power-factor 80 per cent., and thus the apparent efficiency .80 x .86 = 68.8 per cent. With the synchronous motor the efficiency is 89.5 per cent., power-factor, 95 per cent., and apparent efficiency 85 per cent. The power-factor is maximum at 118 kilowatts, and is then 100 per cent. For lighter loads the current is leading and the inductance factor negative; for heavier loads positive and the current lagging behind the E. M. F.

III.—THE MOST ECONOMICAL SYNCHRONOUS MOTOR, WHEN THE GAIN IN LINE COPPER ON ACCOUNT OF THE COMPENSATION OF IDLE CURRENTS WILL BE LARGE ENOUGH TO WARRANT THE INSTALLING OF A SYNCHRONOUS MOTOR AT THE RECEIVING END OF THE LINE.

We assume that the power required at the receiving end is determined.

Let c = energy current in the receiving circuit.
E = E. M. F. at the receiving end of the circuit.
$\cos\phi$ = power factor of the receiving circuit.
c_1 = synchronous motor current.
k_0 = cost of line copper per watt in cents.
k = cost of synchronous motor per watt in cents.
L = cost of line = $k_1 c E$.

k_0 is determined from Fig. 1, which gives the cost of copper (single-phase distribution) per mile distance and per cent. drop at any voltage of the receiving circuit. Of course, the cost is inversely proportional to the drop and directly proportional to the square of the length of the line.

$$\text{Current in line before compensation} = \frac{c}{\cos\phi}.$$

$$\text{Current in line after compensation} = \sqrt{c^2 + (c\tan\phi - c_1)^2}$$

Cost of new line is proportional to the square of the ratio of the currents, thus : $= L\left[\frac{c^2 + (c\tan\phi - c_1)^2}{\frac{c^2}{\cos^2\phi}}\right]$

the gain is therefore : $= L - L\cos^2\phi\left[\frac{c^2 + (c\tan\phi - c_1)^2}{c^2}\right]$

$$= 2k_0 cc_1 E\sin\phi\cos\phi - k_0\frac{c_1^2}{c}\phi\cos^2\phi - kc_1\phi \qquad (E)$$

equals a maximum, or :

$$c_1 = c\tan\phi - \frac{k_1 c}{2k\cos^2\phi} \qquad (F)$$

this equation giving the most economical synchronous motor current.

The gain is

$$S = \frac{cE}{100}\left[(2c-1)k_0\sin^2\phi - kc\tan\phi + \frac{k^2}{4k_0\cos^2\phi}\right] \qquad (G)$$

The power factor in the new system is given by the equation $\cos\phi_1 = \sqrt{\frac{4(k_0{}^1)^2}{k^2 + 4(k_{0\,1})^2}}$

or the power factor is constant where

k = cost of synchronous motor per watt.
k^1_0 = cost of line copper at power factor = unity.
$\cos\phi_1$ = power factor in new system.

In Fig. 14 are given two curves showing the most economical size of synchronous motors to be installed in the receiving circuit for reducing the lagging currents and consequently the line copper. The size is calculated from equation (F) and is thus the most economical capacity.

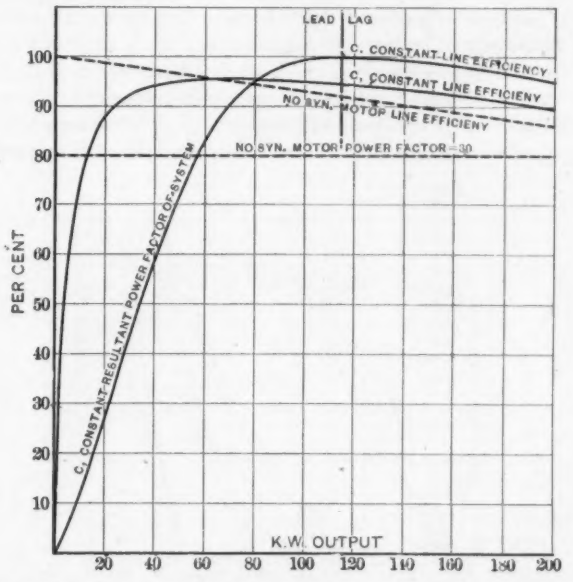


FIG. 13.—EFFICIENCY AND POWER FACTOR AT VARIOUS LOADS, AT 80 PER CENT. POWER FACTOR LOAD, WITHOUT AND WITH SYNCHRONOUS MOTOR.

It is evident that since the reduction in the investment of line copper due to the compensation of the idle currents by the synchronous motor must pay for the synchronous motor, the synchronous motor will have to be installed at a comparatively high power factor in long-distance distribution where the cost of line copper is predominating and at a low power factor when the line is short and the cost of line copper small compared with the cost of the plant.

In Fig. 14 are plotted two curves, the following constants being used :

200 kw energy delivered in the receiving circuit.
c = 200.
E = 1000.
Cost per lb. of copper = 12 cents.
Loss in line 10 per cent.
k = cost of synchronous motor = 2 cents per watt.
Length of line one mile — two miles.
k_0 = cost of copper per watt at power factor $\cos\phi$.

As seen from the curves, when the distance between the generator and synchronous motor is comparatively short, a very poor power factor is required in order that the cost of the synchronous motor will be repaid by the saving in line copper, in one instance as low as 38 per cent. Furthermore the size of synchronous motor increases very rapidly with decrease in the power factor.

If, however, the distance is twice as long, it will be advantageous to install a motor when the power factor is 85 per cent. With a 75 per cent. power factor the most economical size of synchronous

motor would have a capacity of 57 kilowatts; with 65 per cent. 110 kilowatts, etc.

The saving made by installing this motor is found by equation G, and is in the case of a 75 per cent. power factor equal to $1200 and with a 65 per cent. power factor $3000.

However, the gain is in reality larger since with increased synchronous motor current the lagging currents decrease, consequently the total current in line and also in generator. Therefore the generator capacity need not to be the same in both cases, but is smaller when the synchronous motor is used as compensator.

The power factor in the new system is obtained from equation (H) and is as seen constant regardless of the previous power factor, depends only upon the relative cost of the synchronous motor and the power.

IV.—MOST ECONOMICAL SIZE OF SYNCHRONOUS MOTOR, WHEN THE SAVING IN LINE COPPER AND GENERATOR COST BY THE REDUCTION OF THE IDLE CURRENTS WITH THE SYNCHRONOUS MOTOR USED AS COMPENSATOR WILL PAY FOR THE INSTALLING OF THE MOTOR.

The cost of the line for constant drop is proportional to the square of the current.

The cost of the generator is proportional to the current and the cost of the synchronous motor also proportional to the current.

c = energy current of the load; is assumed constant.
c_1 = synchronous motor current.
E = E. M. F. at receiving end of the line.
$\cos \phi$ = power factor of the load.
L = cost of line = $k\, c\, E$ where
k_0 = cost of copper per watt output,
g = cost of generator = $k_2\, c\, E$, where
k_2 = cost generator in cents per volt-ampere.
S = cost of synchronous motor = $k\, c_1\, E$, where
k = cost of synchronous motor in cent per volt-ampere.

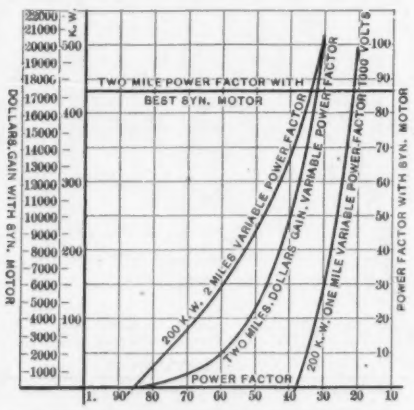

TWO MILE POWER FACTOR WITH BEST SYN. MOTOR
200 K.W. 2 MILES VARIABLE POWER-FACTOR
TWO MILES DOLLARS GAIN, VARIABLE POWER-FACTOR
200 K.W. ONE MILE VARIABLE POWER-FACTOR
POWER FACTOR
DOLLARS GAIN WITH SYN. MOTOR
POWER FACTOR WITH SYN. MOTOR
VOLTS
1000

FIG 14.—MOST ECONOMICAL SYNCHRONOUS MOTOR FOR COMPENSATION OF LAGGING CURRENTS.

The current in the line after compensation is equal to

$$\sqrt{c^2 + (c \tan \phi - c_1)^2}$$

therefore the cost of new line corresponding to this current and same loss is

$$L \left[\frac{c^2 + (c \tan \phi - {}_1c)^2}{\frac{c\,2}{\cos^2 \phi}} \right]$$

$$\text{Gain in line copper} = L \left[\frac{1 - c^2 + (c \tan \phi - c_1)^2}{\frac{4^2}{\cos^2 \phi}} \right]$$

Cost of proper generator after compensation

$$= g \frac{\sqrt{c^2 + (c \tan \phi - c_1)^2}}{\frac{c}{\cos \phi}}$$

Gain by using smaller generator

$$= g \left[1 - \frac{\sqrt{c^2 + (c \tan \phi - c_1)^2}}{\frac{c}{\cos}} \right]$$

Cost of synchronous motor = S. Thus we get

$$L \left[1 - \frac{c^2 + (c \tan \phi - c_1)^2}{\frac{c^2}{\cos \phi^2}} \right]$$

$$+ g \left[1 - \frac{\sqrt{c^2 + (c \tan \phi^2 - c_1)^2}}{\frac{c}{\cos \phi}} \right] - S \text{ for a maximum.}$$

The solution of this equation leads to a complete cubic equation which cannot be solved except by approximation.

It is, however, possible to get a solution by graphic construction as follows:

The cost of line and generators is calculated at the desired power factor of the load, and from these the cost at non-inductive load by multiplying by the ratio of currents square respective currents. Knowing these we construct two curves A and B, Fig. 15, giving the increase in cost of line and generator at any power factor and curve c, giving the total cost of generator and line at any power factor of the load.

At any power factor of the load, and at any desired increase in power factor the proper synchronous motor is calculated thus:

$\cos \phi$ = power factor of the load.
$\cos \phi_1$ = power factor of the load after compensation.
c = energy current of receiving circuit.
$c_1 = c\,(\tan \phi = \tan \phi)$.
E = voltage at receiving end = synchronous motor E. M. F.
$c_1 LE$ = gives the capacity of synchronous motor.

Consequently we know for any resultant power factor the capacity and cost of the synchronous motor. Curve D gives the cost of such a synchronous motor for any increase in power factor for any desired power factor of the load.

The total cost of the plant less the cost of line and generator with non-inductive load is obtained by adding curves C and D and is plotted in curve E.

The lowest point on this curve gives the minimum cost of the plant and the resultant power factor.

Constructing a number of these curves we find the most economical synchronous motor at any power factor of the load, and the cost of the system with the synchronous motor as compensator. The gain by installing the motor is of course the difference in cost of the plants with synchronous motor and without synchronous motor.

In Fig. 15 are plotted curves showing these relations in a plant of following constants:

200 kilowatts at receiving end of line.
Voltage at receiving end of line = 1000 volts.
Line is two miles long.
Loss in power in line 10 per cent. of power delivered to the receiving circuit.
Cost of copper, 12 cents per pound.
Cost of generator and synchronous motor $20 per kilowatt.

Calculating out this plant with non-inductive load, we find that the cost of line copper will be $4.08 \times 200 \times 2^2 = \$3250$. Cost of generator $= 200 \times 20 = \$4000$.

The equation for curve A, gives the increase of cost of line copper with decreasing power factor.

Equation for curve B the increase in generator cost with the decrease of power factor.

Consequently equation for curve C, which is the sum of A and B, is:

$$x_3 = 3250 \left(\frac{1}{\cos^2 \phi} - 1 \right) + 4000 \left(\frac{1}{\cos \Phi} - 1 \right)$$

which curve gives the total increase in cost of line and generator with decreasing power factor.

The cost of synchronous motor capable of changing the power factor from $\cos \phi$ to $\cos \phi_1$ — is expressed by the following equation:

$$x_4 = \frac{C_1 E \times 20}{100} = .02\, E\, C \left(\tan \phi - \tan \phi_1 \right)$$

and is plotted at curve D.

As an instance of the application of this formula, let us calculate the cost of a synchronous motor capable of changing the power factor from 50 per cent. to 90 per cent., thus:

$\cos \phi = .5 \quad \phi = 60° \quad \tan \phi = 1.73.$
$\cos \phi_1 = .8 \quad \phi_1 = 36° \quad \tan \phi_1 = .73.$

Curve E is the sum of C and D and is readily obtained by direct summation.

When curve E, which now represents the entire cost of the plant minus the cost of the generator and line at non-inductive receiver circuit, is found and plotted, the minimum value of this curve gives, of course, the most economical plant.

The most economical synchronous motor is found directly from curves E and F.

So, for instance, in our diagram the most economical synchronous motor for a power factor of 70 per cent. of the receiving-circuit cost from curve D $2500, that is, has a capacity of $\frac{2500}{20} = 125$ kilowatts.

We have thus found how, in any practical case, an investigation of the advantages of using a synchronous motor as compensator

can be undertaken, and how the proper capacity and gain can be found.

We have, as stated above, assumed that the synchronous motor is solely used as compensator, but it is, of course, possible to use the same motor partly as compensator and partly as motor, doing mechanical work.

In fact, it is more economical if the synchronous motor can be used for both purposes, as will be seen in the following short investigation :

Assume the maximum current of the synchronous motor to be c_0 the energy current corresponding to the useful work done by the synchronous motor to be c, and the maximum leading current to be $c_1 = \sqrt{c_0^2 - c^2}$.

The cost of the synchronous motor is $c_0 E k$.

The income from the energy current corresponds to a motor of capacity c E, or one costing $= k c E$. The income of the motor brought about by its compensation of idle currents corresponds to a motor of capacity $c_1 E$ costing $k c_1 E$.

Thus the gain by using the motor partly as compensator and partly as energy deliverer is $k c E + k c_1 E - c_0 E k = kc E + k E \sqrt{c_0^2 - c^2} - c_0 E k$.

This gain is maximum for $c = \frac{c_0 \sqrt{2}}{2}$ or the angle of lead in the motor should be 45 per cent. The gain will then be $.41 \times k c_0 E$.

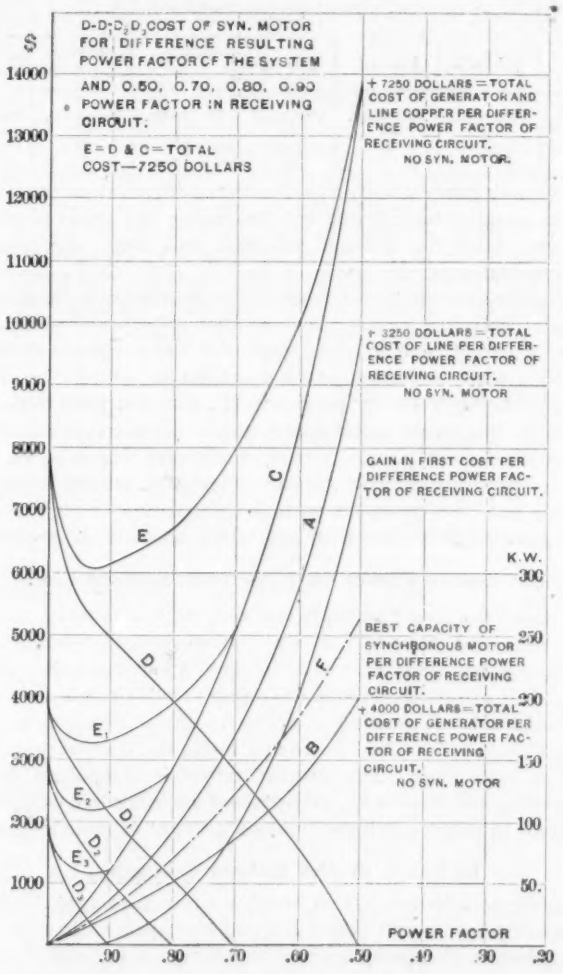


FIG. 15.—CALCULATION OF MOST ECONOMICAL SYNCHRONOUS MOTOR.

That is if it is possible to utilize a synchronous motor as compensator and also for doing mechanical work at such a rate that the energy current is 70 per cent. of the total, and the current flowing to the motor has its full load value, and further that with increase of field excitation the current increases (which shows it is leading the E. M. F.), we have the most economical system and we get about 40 per cent. more useful current (partly as leading current, partly as energy current) than by using the synchronous motor solely as compensator or solely as mechanical motor.

An investigation of the proper size and gain by using such motor is carried out on similar lines as those given when the synchronous motor is used only for compensation; c_1 then only corresponds to the wattless; that is, the leading component of the current.

Calculation of Electric Motors.

BY ALFRED E. WIENER.

(*Concluded from page 694.*)

Constant Speed.—The important requirement of constant speed under variable load may be almost perfectly met by the compound-wound motor, is nearly met by the shunt-wound motor, and is not met without the aid of special mechanism by the series-wound motor. A compound-wound motor will maintain its speed perfectly constant under all loads, if the series-winding is so adjusted that the increase of current strength through the series-coils and armature shall diminish the M. M. F. of the field magnets to the degree necessary to compensate for the drop of pressure in the armature winding.

If constant speed is required, such as is the case in operating silk mills and textile machinery, the compound motor will therefore be found to give the best satisfaction, since in shunt motors, although running with "practically constant" speed, the variation may be too great to be without influence upon the product of manufacture.

When started without load the speed of a shunt motor gradually increases and reaches a maximum from which it falls down again as soon as the load is put on. The rise at no load is due to the fact that since the potential at the field terminals is constant, the field current decreases as the resistance of the field coils increases, owing to their heating, thereby decreasing the magnetizing power, and in consequence the counter E. M. F. of the motor. The subsequent decrease of the speed is caused by the increase of the armature current with increasing load, and by the heating of the armature due to the passing current, the counter E. M. F. decreasing with increasing drop of voltage in the armature. Tests made by Thomas J. Fay * with shunt motors of various sizes gave the results compiled in the following Table III:

TABLE III.—TESTS ON SPEED VARIATION OF SHUNT MOTORS

Capacity of motor. H.P.	Normal speed at no load, cold. Revs. p. m.	Increase of speed from no load cold to no load hot, due to heating of field coils.	Decrease of speed from no load hot to full load hot, due to heating of armature.	Final change in speed. = Increase. − Decrease.
3	1400	20 % of normal speed.	12 % of normal speed.	+ 8 % of normal speed.
5	1200	8⅓ " " "	5 " " "	+ 3⅓ " " "
7½	1360	5¼ " " "	4 " " "	+ 1¼ " " "
10	1200	2 " " "	8⅔ " " "	− 6⅔ " " "
15	1180	2½ " " "	3½ " " "	− 1 " " "
20	860	½ " " "	4 " " "	− 3½ " " "

From this table it will be seen that the resistance of the field and of the armature can be so proportioned with relation to each other that the final speed at full load hot is equal to the normal speed at no load cold. But in order to reduce to a minimum the variation of the speed during the period of heating up of the motor it is necessary that both the increase due to the heating of the magnet coils and the decrease due to the heating of the armature should be reduced as much as possible. For this purpose the field winding should be so proportioned as not to heat very much above the temperature of the surrounding air, and the armature resistance should be as low as possible.

III. CALCULATION OF CURRENT FOR ELECTRIC MOTORS.

A. Current for Any Given Load.—The current in the armature of a motor for any load P_x'' watts $= 746 \times hp_x$ horse-power, at the pulley, since at any instant the entire energy supplied to the motor must be equal to the sum of the expenditures, can be found from the equation :

$$E \times (I'_x + I_{sh}) = P_x'' + I'^2_x \times (r_a + r_{se}) + E \times I_{sh} + P_o''$$

which gives : $$I_x = \frac{E - \sqrt{E^2 - 4 (r_a + r_{se}) \times (P_x'' + P_o'')}}{2 (r_a + r_{se})}, \quad (14)$$

where E = Line potential supplied to motor terminals, in volts;
I_x = Current in armature of motor, in amperes for any given load;
I_{sh} = Current in shunt-field of motor, in amperes;
P_x'' = Useful load of motor, in watts;
P_o'' = Energy required for no load, in watts;
r_a = Armature resistance, in ohm;
r_{se} = Series field resistance, in ohm.

* "Constant Speed Motors," by Thos. J. Fay, *Electrical Age*, Vol. XV., p. 38 Jan. 19, 1895.

Formula (14) directly applies to series and compound-wound motors; in case of shunt-wound motors, r_{se} being $= o$, it reduces it to:

$$I_x' = \frac{E - \sqrt{E^2 - 4\, r_a \times (P_x'' + P_o'')}}{2\, r_a} \qquad (15)$$

By means of this formula the current required for a load of $P_x =$ 20,000 watts imposed upon the motor, given in the example above, is found:

$$I_x' = \frac{200 - \sqrt{200^2 - 4 \times .08 \times (20{,}000 + 4000)}}{.2 \times .08} = 125 \text{ amperes.}$$

b. Current for maximum commercial and electrical efficiency.*—As the energy commercially utilized in a motor is:

$$P_2'' = E \times I^1 - I^2 \times (r_a + r_{se}) - P_o'',$$

and the entire energy supplied is:

$$P_2' = E \times I' + P_{sh};$$

the commercial efficiency can be expressed by

$$\eta_c = \frac{E \times I' - I'^2 \times (r_a \times r_{se}) - P_o''}{E \times I^1 + P_{sh}},$$

and similarly, the electrical efficiency, by:

$$\eta_e = \frac{E \times I' - I'^2 (r_a + r_{se})}{E I' + P_{sh}},$$

P_{sh} being the energy absorbed in the shunt.

These efficiencies are maxima for:

$$I = \sqrt{\frac{P_{sh} + P_o''}{r_a + r_{se}} + \left(\frac{P_{sh}}{E}\right)^2} - \left(\frac{P_{sh}}{E}\right), \qquad (16)$$

and

$$I = \sqrt{\frac{P_{sh}}{r_a + r_{se}} + \left(\frac{P_{sh}}{E}\right)^2} - \left(\frac{P_{sh}}{E}\right), \qquad (17)$$

respectively. Formula (16) therefore gives the current that must be supplied to the armature of a motor in order to have maximum commercial efficiency, and formula (17) the current for maximum electrical efficiency.

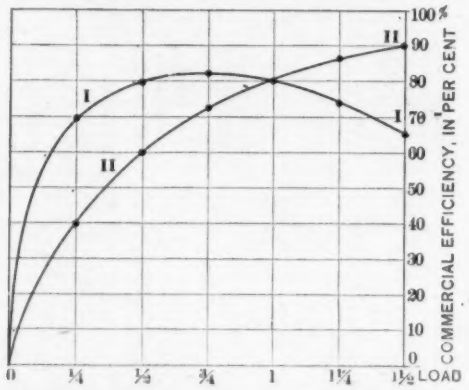


Fig. 16.—Efficiency Curves of Two Motors of Different Design.

Assuming that the shunt field resistance of the above motor is $r_{sh} = 65$ ohms, the energy consumed in the shunt, at a pressure of $E = 200$ volts, is

$$P_{sh} = \frac{E^2}{r_{sh}} = \frac{200^2}{65} = 615 \text{ watts,}$$

by (16), consequently, the current for maximum commercial efficiency:

$$I' = \sqrt{\frac{615 + 4000}{.08} + \left(\frac{615}{200}\right)^2} - \left(\frac{615}{200}\right) = 237 \text{ amperes,}$$

and, by (17), that for maximum electrical efficiency:

$$I = \sqrt{\frac{615}{.08} + \left(\frac{615}{200}\right)^2} - \left(\frac{615}{200}\right) = 85 \text{ amperes.}$$

IV. Designing of Motors for Differing Purposes.—According to the purpose a motor has to serve, its efficiency is desired to either be high and nearly constant over a wide range of its load, or to increase in proportion with the output and be highest at the maximal load the motor can carry.

The shape of the efficiency curve of a motor depends upon the proportioning of its various losses. The losses in a motor are of two kinds, fixed and variable. The fixed losses are those due to the shunt field current, hysteresis and eddy currents, brush friction, bearing friction and air resistance. The variable losses are those due to armature and series resistance, and to commutation, and increase with the load. If the fixed losses are small compared with the variable ones, the efficiency at light loads will be high and will rapidly drop as the load, and with it the variable loss, increases. If, on the other hand, the fixed losses are very large, and the variable losses small, the efficiency with small loads will be low, but will increase as the load becomes greater, for the reason that the total energy increases proportional to the load while the losses in this case remain nearly constant, increasing but very little with the load.

In order to have the fixed losses in a motor small and the variable losses great, it is necessary to employ a massive magnetic circuit with few shunt ampere-turns, an ample cross-section of iron in the armature core, and a large number of turns on armature and series field; hence the energy lost in shunt field excitation, in hysteresis and eddy currents is small, but that lost by armature and series-field resistance and by commutation is great. The reverse of these conditions ensures an increase in the fixed or a decrease in the variable losses.

Curves I. and II., Fig. 1, show the variation of the commercial efficiency with the load in two motors of different design, both having the same efficiency, $\eta_c = 80$ per cent. at normal load, but I. having very high efficiencies at light loads, while II. has very low efficiencies at small loads, but even greater than normal efficiency with overloads:

	Efficiency at Various Loads.					
	¼ Load.	½ Load.	¾ Load.	Normal Load.	25 Per. c't. Overload.	50 Per c't. Overload.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
I.	70	80	83	80	73	65
II.	40	60	72	80	86	90

An efficiency curve similar to I. is desired in constant power work where the greatest load is put on the motor but once in starting and where, after the friction of rest has been overcome, the motor is called upon to work on half to three fourths its normal output continually; motors, consequently, which are to be employed for running printing presses, machine shop tools, power pumps, etc., must be designed with a heavy frame of low magnetic density, a weak field, small excitation and a powerful armature. In order to obtain an efficiency curve similar to II., which is preferable in all cases where the motor is not doing steady work, but is called upon to give more than its normal power at frequent intervals, as, for instance, in operating electric railways, elevators, cranes, hoists, etc., the motor must be provided with a light frame of high magnetic density, a strong field, powerful excitation and a weak armature.

* "Shunt Motors," by W. D. Weaver, The Electrical World, Feb. 25, 1893 Vol. XXI, p. 137.

New Motive Power on New York Surface Lines.

It is stated that the Fourth, Sixth and Eighth Avenue horse-car lines in New York City will, in the Spring, be equipped with new motive power, but what class will be adopted is not definitely known, although it is hinted that the underground trolley system will probably be selected. A meeting of directors of the Metropolitan Street Railway Company is to be held to determine the form of power to be utilized on these lines. The electric system, it is reported, seems to be favored by the directors. Compressed air is not looked upon with much favor in respect to these lines on account of their length.

In Favor of the Edison Company.

According to a dispatch from London a few days ago, the Judicial Committee of the Privy Council allowed an appeal with costs to the Edison Electric Company against the Westminster and Vancouver Tramway Companies, the Bank of British Columbia and others. The Supreme Court of British Columbia granted a judgment in favor of the Bank of British Columbia against the tramway companies to the prejudice of the Edison Company, who is a creditor, and it was against this decision that the Edison Company took an appeal. The action of the Supreme Court of British Columbia is declared by the Judicial Committee of the Privy Council to be null.

The Brighton & Rottingdean Electric Road Destroyed by a Storm.

Last week violent gales occurred along the English coasts, causing much damage. The Marine Electric Railway, which ran along the shore from Brighton to Rottingdean, was destroyed by the storm during the night of Dec. 5. This road was but recently opened, and was briefly described in a recent issue of The Electrical World.

On the Resistance of the Electric Arc.*

BY JULIUS FRITH AND CHARLES RODGERS.

There seems to be some uncertainty as to what is meant by the resistance of the arc. Any given arc is a phenomenon which exists at a definite P. D. and current, and any attempt to measure its resistance must alter the state of the arc as little as possible or else we are no longer dealing with the same phenomenon. Hence it seems to us that the only way in which the resistance of the arc can be measured is by the ratio of a very small increment of P. D. applied to the small increment of current produced. It must also be borne in mind that the change in the current must be of so short a duration that the form of the carbons is not in any way altered.

Apparently the only method which fulfils these conditions is one in which a small alternating current is used, superimposed on the main continuous current. This has the effect of rapidly increasing and decreasing by a small amount the current passing through the arc. It seems probable that the effect on the arc of each small increase of current is annuled by the decrease of current immediately following. In fact a comparatively large alternating current may be superimposed on the main continuous current without producing any visible effect on the arc.

We are thus led to define the resistance of the arc as the ratio of a small increment of P. D. applied to the small increment of current produced. This may be briefly written $d\,V/d\,A$. It is most important to distinguish this quantity, which we call the "instantaneous" $d\,V/d\,A$, from the tangent of the inclination of the tangent line of the curve representing the steady values of V and A, which we will call, for the sake of clearness, the "steady" $d\,V/d\,A$.

We have performed some experiments to exemplify the difference that exists between these two quantities, and also to show that in cases analogous with the arc, where, however, the result can be verified, the instantaneous $d\,V/d\,A$, found by superimposing an alternating current gives correct values for the resistance.

In one of these experiments a glow-lamp, taking 10 amperes at about 8 volts, was placed in series with three I. E. S 50-ampere accumulators, and a current sent through against the E. M. F. of the cells. This arrangement is just what is wanted to test the method,

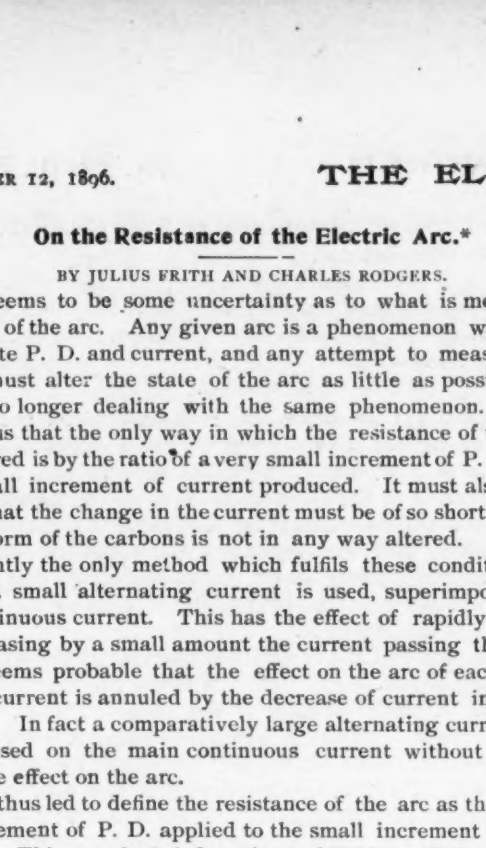


FIG. 1.

namely a resistance in series with a back E. M. F., both of which are functions of the current; and further, the resistance can be separated from the back E. M. F. and measured, and the result compared with the value obtained for the resistance by the instantaneous $d\,V/d\,A$.

The result of this experiment is represented in Fig. 1. Here are plotted the curves connecting the current and P. D. between the outside terminals of the arrangement, and also between the terminals of the lamp and of the battery. This last gives the back E. M. F., since the resistance of the cells was small enough to be neglected. The P. D. at the lamp divided by the current gives the resistance; this is plotted on the same diagram. To make it clearer, however, the scale of ohms is multiplied by 10. We have measured† the instantaneous $d\,V/d\,A$ at various current strengths, and the values of this are plotted in a dotted line. It is seen that there is a very

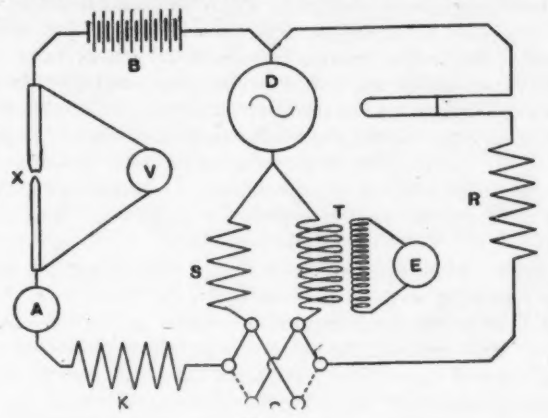


FIG. 2.

close agreement between these two measurements of resistance. On the same sheet are plotted values for the steady $d\,V/d\,A$. This differs considerably from both the resistance-curves. This leads us to see that the rapid excursions caused by the alternating current are not along the curve joining the steady values of V and A, but along a line which is everywhere more vertical than the tangent to the curve. This line is formed by joining the point on the curve to the instantaneous origin, which is distant from the origin of the diagram by an amount equal to the back E. M. F. at that particular current. Were the electrical excursions to travel along any intermediate path, the value obtained for the instantaneous dV/dA would be dependent on the frequency. As will be seen later, this is not the case between the experimental limits of 250 and 7 complete alternations per second. If therefore the arc, as has been affirmed by various authorities, consists of a back E. M. F. and a resistance we feel justified in applying this method for the measurement of its resistance which has been found correct in closely analogous cases. Now at very low frequencies indeed the electrical oscillations would travel along the curve connecting the steady values of V and A; and this is clearly the meaning of the critical frequency which we have observed with cored carbons, namely, that under the critical frequency the superimposed alternations travel on the steady value curve and become identical with the "steady" $d\,V/d\,A$.

Several experimenters have obtained values for the resistance of the arc which agree fairly well among themselves, and which seem to show that the arc has a positive resistance.

It was pointed out, however, by Prof. Ayrton, at the Ipswich meeting of the British Association, that although there was a marked agreement between the values obtained by these experimenters, they were not at all in accordance with the conclusions drawn by himself from consideration of the curves obtained by Mrs. Ayrton. These curves connect the P. D. Between the carbons with the current passing through the arc, for various fixed lengths of arc, and from them it is seen that for a given arc-length an *increase* of P. D. is always accompanied by a *decrease* of current. From this fact Prof. Ayrton concluded that if an attempt were made to measure the resistance of the arc by altering the P. D. between the carbons and finding the corresponding alteration of current produced, the resistance found by taking this ratio must be *negative*.

This conclusion was strengthened by some experiments made by Mr. Mather at Prof. Ayrton's suggeston. In one of these experiments two points of equal potential were found in a circuit consisting of an arc, a battery and a resistance. Another battery, consisting of a few cells of known E. M. F. and resistance was applied between these two equipotential points and the current flowing through the battery was noted. The resistances of the two parallel halves of the circuit, excluding the arc, were known, so that the current which, taking the arc resistance as zero, should flow through this battery could be calculated. Now the value of this calculated current was found to be less than the observed value, no matter in

* Paper read before the London Physical Society, May 8, 1896, and communicated to the *Philosophical Magazine*.

† By method I.

which direction the P. D. was applied, and this result was also obtained when an alternating P. D. was used. Hence the resistance of the arc was apparently less than zero.

The other experiment consisted in running the arc at a steady P. D. and current, suddenly altering the resistance in circuit by a small amount, and noting the changes in the ammeter and voltmeter-readings so produced. The new conditions were maintained only long enough to allow of these readings being taken. The arc was then brought back to its former condition before taking another reading. It was found that a change of P. D. in *one* direction was always accompanied by a change of current in the *opposite* direction. The results of both experiments, were, however, only qualitative.

All these experiments, together with the consideration of the curves found by Mrs. Ayrton, lead to the conclusion that the arc has a *negative* resistance, while former experimenters had all obtained a *positive* resistance. It was in order to throw some light on this discrepancy that we undertook a series of experiments to determine with some degree of accuracy the resistance of the arc under various conditions.

METHODS.

A number of methods were tried using alternating currents, of which the following were most successful :

Method I. is represented diagrammatically in Fig. 3. D is the armature of an alternator, the current from which passes round two circuits in parallel, one of which contains the arc X, and the other an adjustable resistance R. By adjusting R the alternating currents in the two halves can be made equal. When this is the case the impedances of the two halves to alternating currents must be equal. In the diagram the continuous-current circuit is shown to the left. It consists of a battery of accumulators B, the hand-adjusted arc-lamp X, the resistance K, the ammeter A, and (with the commutator C as shown) the resistance S and the alternator D. It will be noticed that the alternator D carries the continuous current, but this of course does not prevent its acting as an alternator. In order to measure the small alternating current independently of the continuous current flowing we used the air-transformer T, the thick wire coil of which was in series with the alternator D, the thin wire coil being connected with an electrostatic voltmeter E. The reading of the electrostatic voltmeter is thus unaffected by the continuous current, while it is, at a given frequency, a measure of the alternate current flowing. By means of the commutator C, the air-transformer T can be thrown into either circuit, the resistance S being by the same operation thrown into the other circuit. The resistance

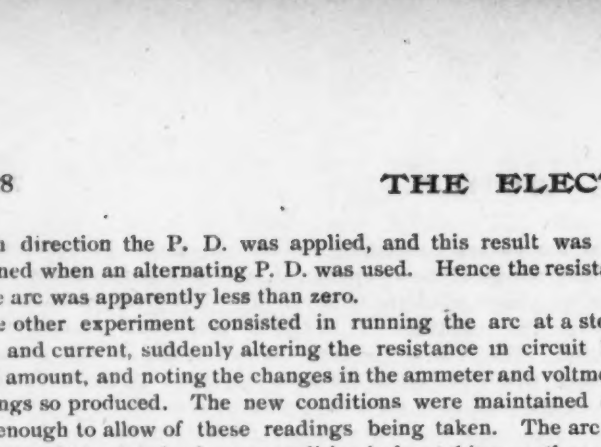


Fig. 3.

S is equal to that of the thick wire coil of T, so that when S replaces T the continuous current is unaffected by the change.

METHOD OF EXPERIMENTING.

The arc was run at the required current and P. D. by alternating the number of cells in B, K being always kept the same. The current was kept constant by adjusting the arc by hand. Under normal conditions the current could be kept constant to within 1 per cent. R was now adjusted till the deflection of E was the same when T was in either circuit. When balanced a change of 0.01 ohm in R caused an appreciable difference in the deflections of E. It was found to be useless to adjust more accurately than this, since the small variations in quality always found in carbons produced differences of this order in the resistance of the arc.

Let the value of R when a balance is obtained be R_1. This is equal to the resistance, to alternating-currents, of the battery (b_1), the resistance (k), the arc lamp and connections (l), and the arc (x).

$$\therefore \quad R_1 = k + b_1 + l + x. \qquad (1)$$

The carbons are now firmly screwed together and the number of cells in B reduced till the continuous current is the same as before. R is again adjusted till the deflections of E are equal; and if R_2 is the new value thus obtained,

$$R_2 = k + b_2 + l; \qquad (2)$$

b_2 being the resistance of the portion of the battery now used. The cells are next cut out, the mains leading to them short-circuited, and a third value R_3 obtained,

$$R_3 = k + l. \qquad (3)$$

From (2) and (3) we obtain the resistance of b_2, and by proportion of any number of cells. Putting these values in (1) we obtain the value of x in ohms. The advantages of this method are that no calibration of the electrometer is required, the speed of the alternator need not be constant for long periods together, various alternators giving different frequencies, and wave-forms can be used without materially altering the circuit, and especially that the resistance of the arc can be obtained directly in ohms as the difference of two readings of the box R.

Method II. is shown diagrammatically in Fig. 4; the arc circuit in this case being shown to the right. X is the arc, B the battery of accumulators, K the resistance, A the ammeter, and V the voltmeter across the arc. B and K were made large, K being about 11 ohms. The circuit shown on the left consists of the alternator D, the transformer T, which together with E is now used simply as a delicate alternate-current ammeter, a condenser F, and a commutator C. By means of C we can put in circuit either the resistance R or the arc lamp X in series with the resistance S. The alternating current flowing through K is negligible compared with that flowing through X on account of the high resistance of K. The condenser F prevents any continuous current due to the P. D. at the arc from passing through the alternator.

METHOD OF EXPERIMENTING.

If L is the self-induction of the circuit and F its capacity, the impedance I of the circuit is given by $\sqrt{R^2 + \left(\frac{1}{F\omega} - L\omega\right)^2}$, where $\omega = 2\pi \times$ frequency. This is a minimum when $L F \omega^2 = 1$. The alternator was run at a speed corresponding to this frequency, at which the arrangement is most sensitive to changes of R.

An experiment consists in adjusting R till the deflections of E are the same whether R or $S + x$ is in circuit. Then

$$R = S + x.$$

The experiment was first tried without a resistance at S, but it was found impossible when using solid carbons to obtain a balance even when R was zero. In order to make it possible to obtain a balance with R greater than nothing, a resistance S numerically greater than the negative resistance of the arc had to be put in series with the arc. In our experiments we kept S constant and adjusted R. The experiment might have been performed by making $R = 0$, and adjusting S till the readings of E were equal. Then $S + x$ must be equal to zero, and therefore $x = -S$, or *the resistance of the arc is equal to the resistance in the box S with its sign changed.* This method gives results which agree well with those obtained by Method I.; but on account of the necessity of keeping the speed of the alternator constant the arrangement is more troublesome to manage, and therefore was used only as a check method.

DESCRIPTION OF THE APPARATUS.

The *arc* lamp had a hand adjustment for each carbon with centering arrangements for the positive. The arc-length was measured by projecting an image of the arc onto a screen by means of a lens in the usual way. The *resistance* K consisted of broad platinoid strips bent back on themselves so as to avoid self-induction. It did not heat appreciably with the largest currents used. The *battery* consisted of 50 ten-ampere E. P. S cell arranged in four groups of 10 cells each, four of two, and two groups of one. These groups could be connected up by means of mercury cups. The *ammeter* and *voltmeter* were Weston instruments of the horizontal type. The *air-transformer* T was made in two sections which were usually used in series. The constants were as follows :

Section No. 1:

Fine wire coil.
- Diameter of wire (uncovered) = 4.3 mils.
- Diameter of wire (covered) = 6.8 mils.
- Number of turns..... = 9730.
- Resistance..... = 4707 ohms.

Thick wire coil.
- Size of wire No. 12 S. W. G.
- Number of turns..... = 128
- Resistance..... = 0.143 ohm.

Section No. 2:
Fine wire coil.
Diameter of wire (uncovered) = 3 mils.
Diameter of wire (covered) = 5 mils.
Number of turns..... = 29,500.
Resistance..... = 32,120 ohms.
Thick-wire coil.
Size of wire No. 12 S. W. G.
Number of turns..... = 96.
Resistance..... = 0.112 ohm.

The thick wire was double-cotton covered. The thin wire was silk covered. The *voltmeter* was an Ayrton-Mather reflecting electrostatic voltmeter, giving a deflection of 700 scale-divisions at a distance of 2500 scale divisions for 100 volts. This instrument was admirably adapted to our purpose on account of its very quick swing and excellent damping. The *resistance R* consisted of a box wound with thick German-silver wire plugging to 0.1 ohm, in series with which was a German-silver wire (No. 10 S. W. G.) doubled backed on itself and carrying a slider. Points were marked out at distances corresponding to 0.01 ohm. These spaces were about 10.7 cm long. The alternator: Several different alternators were used. The one used while obtaining the curves given was a Pyke & Harris machine, which was especially suitable, since it had no sliding contract, both armature and field being fixed. The other machines were: For high frequencies a Ferranti, and for low frequencies a Gramme alternator. The fields in all cases were excited by storage cells. The condenser has usually a capacity of about 60 microfarads.

VARIATION OF CONDITIONS.

The conditions of the experiments were varied as much as possible. We have studied the effect on the resistance of the arc of variations in the amount, frequency and wave-form of the alternating current; the effect of different kinds of carbons and different P. Ds. and currents; the effect of using different combinations of cored and solid carbons, of carbons cored with substances other than carbon; and the effect of the relative size of the carbons.

RESULTS.

The amount of alternating current between the limits we have used does not appear to have any influence on the value obtained for the resistance of the arc. The largest alternating current used had a R. M. S. (root mean square) value equal to about 10 per cent. of the continuous current. The smallest had about one tenth of this value. In obtaining the curves shown, the R. M. S. of the alternating current was usually about 0.5 ampere.

The frequency also did not have any effect on the resistance of the arc between the limits 250 and 7 complete alternations per second. Frequencies above 150 were obtained from a Ferranti alternator; those between 150 and 45 from a Pyke and Harris; and those between 24 and 7 from a Gramme machine.

Besides these three machines a Mordey transformer of ratio 1:1 was sometimes used, with its primary in circuit with the Pyke and Harris alternator. On account of its having a closed iron circuit, it was not so suitable, but it gave the same results as the alternators.

We have thus obtained considerable variety in the wave form as well as in the frequency. Hence the wave form does not affect our measurements of the resistance of the arc.

(*To be continued.*)

Effect of Röntgen Rays on the Blind.

To the Editor of The Electrical World:

SIR:—About ten days ago I had the pleasure of trying the Röntgen rays on a blind man, and as the experiment was the first one tried hereabouts and disclosed some new facts, your readers may find it of interest,

The subject was a very intelligent man in middle life, who became blind five years ago, as the result of paralysis. He is to all intents and purposes totally blind, for while now and then able to catch a spark or faint line of brilliant reflected sunlight, he is quite unable to notice arc or incandescent lights within a few feet of his face. The cause of his blindness is stated by the physicians to be paralysis of the optic nerve, substantially complete in both eyes.

On placing him a couple of feet from the tube and exciting it, he at once distinguished the illuminated area and described correctly its general dimensions and shape. The field of vision, however, seemed to be small. He was plainly able to distinguish the flickering of the tube. A metallic sheet cut off this vision entirely, and he was able to see a bunch of keys, the fingers and so forth shadowed on the illuminated surface of the tube.

Now, the interesting feature of the experiment was this: A sheet of cardboard cut off vision as completely as the metal and the subject could see forms and letters cut out of cardboard as shadows against the tube. Closing the eyelids entirely shut out the effective rays and he could get no trace of light from the fluoroscope.

In this case, then, the so-called Röntgen rays produced no sensation of vision, for vision was stopped off by a medium highly transparent to such rays. On the other hand, certain other rays delivered by the tube were clearly visible to him, although they were unable to pass through cardboard or the eyelid.

The tube was of the double focusing type, and it all appeared of nearly uniform brilliancy to him. He described the illuminated area as of a pale pearl-gray color. The effective rays were apparently not the ordinary ultra-violet ones, for an arc light, rich in these rays, is invisible to him, and he was totally unable to see any trace of a most brilliant volley of sparks from the coil delivered a couple of feet from his eyes. It seems highly probable that the rays which impressed themselves on the almost dead retina were more akin to those studied by Becquerel, since they were certainly refrangible and formed an image of the tube. They certainly were not light in the ordinary sense of the word, for to this his eyes do not respond.

At all events, it is an interesting study in selective action. There are many gaps to be filled in between the Röntgen rays and the present ultra-violet end of the spectrum and the complete spectrum of a high-vacuum tube has yet to be investigated. I hope to be able to follow up this line somewhat if I can find time for so doing.

NEWTON CENTRE, MASS. LOUIS BELL.

Electricity on the New York, New Haven & Hartford Railroad.

The New York, New Haven & Hartford Railroad Company is evidently much impressed with the availability of electricity for many purposes in the operation of a railway system. A despatch from Hartford, Conn., announces that that company will begin at once to equip its branch lines in the neighborhood of Hartford with the third rail electric system. A large power-house, it is reported, will be built at Berlin, 10 miles south of Hartford, and it is expected that electric cars will be in operation by February next. The electric system will also be put in on the New England road, between New Britain and Hartford, and cars will be run between New Britain and Berlin and New Britain and Hartford. The distance is about 12 miles from Hartford to New Britain.

This move on the part of the steam road is said to be part of the plan to head off an electric street railway between Hartford and New Britain. Work will be begun at once on the equipment of the third-rail system.

A Norwalk, Conn., despatch states that the New York, New Haven & Hartford Railroad Company, in addition to a more extensive use of electrical power on its branch lines, proposes to light its lines by electricity. Eight plants scattered throughout the State, it is said, will furnish light not only for the stations and signal towers but for the signal lights, and even for illuminating the tracks. The company's engineers believe that four arc lights properly placed will light a mile of straight road so well as to preclude any possibility of accidents from the rare causes from which the block system cannot ensure protection. It is also stated that the Company's electric power may be used for general purposes, aside from railway requirements.

Temporary Telephonic Communication by the Aid of Kites.

Mr. Wm. A. Eddy, of Bayonne, N. J., who has achieved considerable fame through his scientific kite-flying in New York and vicinity, on Dec. 5 made some experiments with the aid of his kites that promise to open up a very important field of application for this particular form of scientific investigation. In these experiments Mr. Eddy sent aloft with his kites a plummet and a telephone transmitter to which was attached the end of a small copper wire. When a height of about 1000 feet was reached the plummet was lowered to the earth, bringing with it the wire. The wire was then grounded at both ends and conversation was held between the two terminal points with very satisfactory results. Telegraph instruments were also operated at different times. These experiments, it is claimed, demonstrated the further utility to which aeroplanes may be put by the army signal corp. Rivers, forests, towns and areas of country where telegraph facilities do not exist, can be thus quickly bridged for the establishment of a temporary telegraph or telephone system, and the success that attended Saturday's experiments led those interested to believe that the kite system was full of possibilities.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

DYNAMOS, MOTORS AND TRANSFORMERS.

First Cost of Transformers. ADAMS. Lond. *Elec.*, Nov. 20.—A short article in which he shows that no general rule can be given for finding the number of secondary turns; an increase in this number is usually accompanied by an increase in the cost of material per kilowatt, but there is a limiting minimum for each size of transformer; the particulars of 11 different transformers were worked out by the writer and the results are given in tables, from which curves are deduced showing the cost in shillings per kilowatt as ordinates and the number of secondary turns as abscissas, and from these curves the number of turns which correspond to the lowest cost of materials is readily obtained, as each curve has a minimum ordinate. With small transformers, however, the cost of the materials is sometimes a secondary matter, as the all-day efficiency in many cases overrules the question of the first cost; a large number of turns may therefore be necessary.

Rotary Transformer. ALIOTH system. *L'Eclairage Elec.*, Nov. 7.—An illustrated description by Guye of a large rotary transformer having a single winding on the armature, for transforming a di-phase into a continuous current; in such machines the ratio of transformation is determined by the construction and cannot be altered, but it is believed that the cost of such a machine in addition to a transformer would be less than the cost of a rotary transformer consisting of a motor and a dynamo. The principle of the construction is well known, being simply a continuous-current machine with two commutators and two sets of contact rings for the alternating current; it is to be installed in the plant in Geneva, where several others like it are already in use.

Alternating-Current Apparatus. SCHULZ. *Elek. Anz.*, Nov. 8.—An illustrated description of some of the generators and motors made by a company in Aix-la-Chapelle.

Alternator. Lond. *Elec. Eng.*, Nov. 20.—A translation in abstract, with some of the illustrations, of the description of the Hutin-Leblanc flywheel alternator mentioned in the *Digest*, last week.

Miniature Electric Motor. Elec. Tech., Oct. 15.—A note stating that the smallest motor ever built was exhibited at the recent Nuremberg exhibition; it is a three-phase motor no larger than a pigeon's egg weighing 400 grammes and yielding about 0.005 horse-power at a speed of 2200; it was running during the exhibition driving a small fan.

LIGHTS AND LIGHTING.

Effect of Wave Form on the Alternating Current Arc. FRITH. *Proc. Lond. Phys. Soc.*, October.—A reprint in full with the discussion of the paper noticed in the *Digest*, May 23.

Arc Lamp. Elek. Anz.—An illustrated description of an arc lamp which regulates by means of long cores in solenoids, the cores being cylindrical and the solenoids conical; it is a differential lamp of very simple construction.

Alternating vs. Continuous-Current Arc Lamps. Elec. Eng., Dec. 2.—A communication from the General Electric Company stating that according to their records the direct-current, long-burning arc lamp seems to be the most in demand, the saving of trimming and carbons having considerable weight with the purchasers; the demand for alternating arcs is still growing; continuous-current arc light circuits are always loaded to their utmost limit while alternating-current machines do not carry their full load and the alternating arc therefore solves this problem of extension; there are great difficulties in developing a really good alternating-current arc; while such lamps are making great strides they are not yet overtaking direct-current lamps.

Spectrum of Reflection. BIRCHMORE. *Elec. Eng.*, Dec. 2; a continuation of his serial.—He discusses the subject of color with the idea of showing that everything possible should be done to get the most effective kind of light from lamps; one of the most important questions is said to be the way in which the blue in the lamps had best be met.

POWER AND HEAT.

Electric Power in Coal Mines. GOICHOT. *Mem. Soc. Eng. Civ.*, September.— A reprint of a very long paper in which he discusses the subject of electrical transmission of power in coal mines; he gives the results of some examinations of English and American mines and concludes with a long description of a project for such an installation for a large mine, which is accompanied by two large plates of illustrations and an estimate of the first cost and the cost of operation.

Electric Transmission in Workshops. HILLIARET. *L'Eclairage Elec.*, Nov. 7.—A continuation of a reprint of his long article. He shows a method of comparing the first cost of maintenance for mechanical transmission with that for separate motors, thus enabling the best system to be predetermined. Some tables are given, quoting the results of measurements made by other writers, one of them giving the efficiencies in the transmission in a few different kinds of factories, and another giving the power consumed by several different kinds of machines.

Centrifugal Machines. DIEUDONNE. *L'Energie Elec.*, Oct. 16.—An illustrated description of direct driven centrifugal drying machines with special reference to the automatic gradual starting of the motor, the speed of which is increased gradually by means of a switch which is revolved slowly, being driven from the main motor shaft.

Volatilization of Some Refractory Bodies. MOISSAN. Lond. *Elec.*, Nov. 20.—A translation, apparently in full, of a French paper in which he describes experiments with the volatilization of some metals and metalloids and the easy distillation of silica and zirconia. In his conclusions he states that at the high temperatures in the electric furnace metalloids and metals which were formerly considered refractory are volatilized, and the most stable compounds in mineral chemistry disappear, either by dissociation or volatilization; the only materials that can resist these high temperatures are a series of new crystalline compounds, namely, the borides, silicides and metallic carbides. The electric furnace seems to realize the conditions of the remote geological period.

Electric Kitchen. L'Energie Elec., Nov. 1.—An illustrated description of an electrical kitchen exhibited at the recent Geneva exhibition, including illustrations of some of the apparatus.

Transmitting Power in Mines. Eng. Mag., December.—A review of the recent articles by R. Kennedy in the Lond. *Elec. Rev.*, all of which have been noticed in these columns.

Niagara Falls Plant. DUNLAP. *Elec. Eng.*, Dec. 2.—An illustrated description of the new plant built by the Niagara Falls Hydraulic Power Company at the edge of the gorge; the plant is now complete.

TRACTION.

Conduit Railway System. Elek. Anz., Nov. 12.—A brief extract of a report of tests made with an experimental line about 500 feet long, in Hamburg, according to the Lachmann system (which is not described; it was illustrated and described in the electrical journals a year or two ago). The leakage on a rainy day was 30 milliamperes for the underground portion and six for the overhead leads; when a conduit was filled entirely with water the leakage was 50 milliamperes; after the car had passed it was 148 milliamperes; the car came to rest while it was passing through the flooded portion. The inventor is prepared to construct such lines at the rate of $6.25 per metre, including paving, with a full guarantee.

Traction Motors. ZIFFER. *Elek. Anz.*, Nov. 15 and 19.—The beginning of a reprint of a recent paper read at a recent meeting in Stockholm; the first portions are devoted to steam and compressed air motors; he reviews the latest inventions and progress in mechanical traction motors.

Mechanical Traction. LAVEZZARI. *Mem. Soc. Ing. Civ.*, September.—A reprint of a paper devoted mainly to gas motors, giving brief descriptions of the systems in use and concluding that this system "merits an honorable place among the other systems," although he admits that there is room for much improvement in it.

Clontarf Electric Railway. Lond. *Engineering*, Nov. 6.—A brief, illustrated description of this line near Dublin, which is under construction by the Thomson-Houston Company.

Gumnden Railway. Zeit. f. Elek., Nov. 1.—An illustrated description of some length, of this railway in Austria, constructed by a local company.

Douglass Southern Railway. Lond. *Lightning*, Oct. 29.—An illustrated description of this overhead trolley road.

Tettnang Railway. Lond. *Elec.*, Nov. 20.—A brief abstract of the article noticed in the *Digest*, Oct. 10.

Storage Battery Railway in Chicago. Elec. Eng., Dec. 2.—An article accompanied by a large number of illustrations giving a brief description of the Englewood and Chicago line "which went into preliminary operation a few weeks ago," two cars on which are now run over a portion of the line. The track is of extra heavy construction; the batteries to be placed on the cars are raised from below by means of elevators,

which are illustrated; three different voltages are used in order to charge the batteries "at nearly a constant rate during the entire period of charge;" they are first connected to the low pressure bus bars, and then successively to the next two higher voltages; the voltages appear to be 190, 170 and 150; it is stated that they are first run on the 190-volt circuit (which does not agree with the other statement, and is apparently an error); to indicate when batteries are fully charged an ampere meter is used which lights an incandescent lamp when the current drops to 25 or 30 amperes. The four generators are connected according to the Arnold system, so that any one or all can be operated; there are no boosters. The equipment will consist of 40 cars, each having 72 cells weighing four tons and capable of delivering 400 amperes at 150 volts (but how long and at what rate is not stated). An illustrated description is also published in the *St. Ry. Jour.* for December.

Electrically Welded Continuous Rail. EYRE. *St. Ry. Jour.*, December.—An article showing the general development of the electrically welded continuous rail and describing the method now used. He believes that the continuous rail now meets all the requirements; the warp is entirely prevented if the track is buried in the roadbed, while the tensile strength is great enough to prevent rupture from contraction. Final success in these joints was attained by making a high pressure butt weld of rail to rail; the cleaning is done by means of a sand blast; such a joint is stronger and tougher than any of its predecessors; nineteen out of every twenty made commercially will stand from 400,000 to 600,000 pounds tensile strain for 6 in. rails, while the greatest strain to which the track will be subjected by cold is 157,500; the hardness of the steel is practically the same after the weld; he considers this method the most economical way of connecting the rails.

Suburban Electric Lines in Cook County, Illinois. Eng. News, Dec. 3.—A note stating that a large company is projecting the erection of nearly 100 miles of electric railways connecting Chicago with a number of suburban towns.

Electric Traction on Steam Roads. Elec. Eng., Dec. 2.—A note stating that the Long Island Railroad intends to use electric traction on their line for the nearby places, and it is thought some motors will be in operation next Summer.

Varese. St. Ry. Jour., December.—An illustrated description of an electric mountain railway of the American type, on the southern slope of the Alps, in Italy.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Method of Charging. Lond. *Lightning*, Oct. 29 and Nov. 12.—A conclusion of the discussion started by Hordern who criticised the Wright system unfavorably; the communications are chiefly from central station engineers and are mainly to the effect that the Wright system is the best; Hordern's contention is that according to this system those consumers who have caused the peak of the load curve and who should therefore bear the whole of the standing-by expenses, are charged less than they should be and are charged less at the expense of those who are demanding their maximum at other than the time of heaviest load, and are helping to flatten the load curve. The discussion is closed by Hordern, who answers his critics at some length but adheres to his contentions.

Leyton. Lond. *Elec. Rev.*, Nov. 20.—A long, illustrated description of this station, the most interesting feature of which is the use of gas engines run with producer gas; a direct-current three-wire system with 300 volts is used in connection with a storage battery and motor generators. The results of a test of over five hours showed that there was a consumption of 1.78 pounds of anthracite and coke consumed per kilowatt, amounting to a cost of less than 0.44 cents per unit.

Central Station Statistics of Switzerland. Lond. *Elec.*, Nov. 20.—Some tabulated statistics for 1895 of 24 central stations in Switzerland.

Vienna. Zeit. f. Elek., Nov. 15.—An extract from a report of the industries in Northern Austria in 1895, in which are given some statistics of the stations in Vienna.

Central Stations vs. Block Stations. OSTERBERG. *Eng. Mag.*, December.—A short article on "Are Electric Central Stations Doomed?" in which he endeavors to show that central stations for lighting and power will be superseded by small isolated plants situated in blocks; the chief difference between the two is due to the great investment and cost of maintenance of the distributing system; he believes it can be shown that electricity can be produced at a greatly reduced cost on a small scale; for steam engines he estimates the cost at 2.31 cents per kw-hour or 4.22 cents for gas engines; he assumes that the boilers could be used at the same time for heating; he makes a rough estimate for a central station for 250,000 lamp-hours per day, and finds it to be about $1,250,000; the cost of 100 small block stations with a storage battery outfit would be about the same; the generating expenses would be less; the blocks might still be under the same management; as an evidence of the advantages he points to the constant increase in the number of isolated plants in large buildings. An editorial abstract of the article is given in the *Elec. Eng.*, Dec. 2.

United States Capitol. Elec. Eng., Dec. 2.—An illustrated description of the lighting and ventilating plant which has recently been installed in the Senate chambers; the two-wire system is used, with incandescent and arc lights on the same circuit.

Geneva. Elec. Eng., Dec. 2.—A reprint of a description noticed in the *Digest*, Nov. 21.

Leyton. El'ty., Dec. 2.—A brief description of the station referred to above.

WIRES, WIRING AND CONDUITS.

Municipal and Free Wiring. Lond. *Elec. Rev.*, Nov. 20.—A short article stating that the Municipality of Shoreditch is to undertake wiring for the actual cost plus 10 per cent. for supervision; arguments for and chiefly against municipal wiring are made; a free-wiring syndicate has also been started; it appears that a consumer can have his premises wired without any first charge by agreeing to pay for five years (?) 1.5 cents per kw-hour more than the others.

Free Wiring. Lond. *Lightning*, Oct. 29.—A brief description of the method adopted by the Free Wiring Syndicate; it intends to enter into working agreements with central stations by which the wiring of consumers' houses is to be undertaken by them for the mutual benefit of both parties free of any initial charge; the consumer is to pay 1.5 cents per kw-hour more for the energy supplied him than one who pays cash for the wiring; this fee is to be collected by the central station and paid over to the syndicate; either the central station or the consumer has an option of purchasing the wiring and fittings at any time after five years from the date of installation, upon "reasonable" terms. Editorially it is calculated that this fee is equivalent to about 5 per cent. on the outlay and it is questioned whether it is a sufficient return on the risk.

Insulation. STINE. *Elec. Eng.*, Nov. 25.—A short article pointing out the fact that until recently the subject of insulation has not received proper scientific investigation, and suggesting briefly the proper methods of making such investigations. He divides the most important properties into three classes, the resistance, the disruptive strength and the hygroscopic qualities, discussing each briefly. The resistance need not be considered as that of an electrolyte; the power of withstanding disruptive discharges is of more consequence than the insulating qualities; substances may be considered as having an elastic limit beyond which they rupture, and this he compares to the brittleness of hard substances; the hygroscopic quality leads to the charring of the insulating material; the influence of this hygroscopic element has not yet been clearly examined in published tests; such tests should show quantitative values for these several properties; the temperature changes of resistance should be made in an enclosed dry atmosphere so as to eliminate the hygroscopic element; tests should then be made at fixed temperatures, but with variable amounts of moisture. He calls attention to the trying demands on insulating material, which is often required to be strong mechanically, although such materials, as a rule, are not so. He calls attention to a mistaken idea which is very prevalent, that switches should make a quick break; there is a certain amount of energy in the circuit which must be spent on breaking, and if it is not spent in the circuit at the break it subjects the insulation throughout the circuit to a sudden and severe strain; the quick break therefore aggravates this strain; the ideal condition would be to gradually reduce the current to a small amount before the circuit is opened; a high E. M. F. of self-induction results when a circuit is abruptly broken, and as this may be enormously higher than the normal it causes a proportionate strain and this occurs usually when the apparatus has become heated from being in use; this is still worse for alternating currents in which the resonance and capacity effects are added; these conditions should not be so generally overlooked; shunt windings of dynamos and motors might be protected by non-arcing discharge points.

ELECTRO-PHYSICS AND MAGNETISM.

Röntgen Radiation. THRELFALL and POLLOCK. Lond. *Elec.*, *Elec. Rev.* and *Elec. Eng.*, Nov. 20; an abstract of a Physical Society paper.—They describe a form of Crookes tube which is easily made and generates a large quantity of rays (this is not described in the abstract). The results of their experiments may be summed up as follows: Röntgen radiation does not consist in the projection of gaseous matter, or if it does the amount of such matter involved is extraordinarily small; Röntgen radiation does not consist in the projection of ether streams having a velocity above a couple of hundred metres per second; this is true whether the radiation takes place in air or in benzine; the properties of the ether, regarded as determining the velocity of electromagnetic waves, are not greatly changed and not at all within their experimental limits by the Röntgen radiation, and this applies alike to the ether in air and in benzine; a selenium cell composed of platinum electrodes and highly purified selenium is affected by Röntgen radiation to an extent which is comparable with the effect produced by diffused daylight; no permanent or temporary E. M. F. is set up in a selenium cell by the Röntgen radiation. The authors came to the first conclusion by exposing an exhausted tube placed in parallel with a spark-gap, so adjusted that the spark just passes over the gap, rather than through the tube, to the Röntgen radiation; they find that a vacuum tube in parallel with a spark-gap is very sensitive to changes in pressure within the tube. The second and third conclusions were arrived at by using Michelson's arrangements for the interference of two beams

of light. In the discussion Bidwell stated that he had obtained negative results in his experiments with the resistance of selenium subjected to Röntgen rays, but thinks it may have been due to the tube. S. P. Thompson mentioned a number of points regarding Röntgen radiation which require clearing up ; Lenard had used as anode a cylinder surrounding the cathode disc, the idea being that with such a symmetrical arrangement the radiation would be more homogeneous, and Thompson suggests adopting some such symmetrical arrangement for producing homogeneous Röntgen rays.

Röntgen-Ray Apparatus. Lond. *Elec. Rev.*, Nov. 20.—A summary of a number of different articles published recently; illustrations of several forms of tubes are given; among them that of Roiti, which is a tube open at one end, at which it is capped with aluminum, which acts both as an anode and an anti-cathode; he states that the size and dimensions of the tube have an important influence; the intensity of the rays does not depend on the vacuum only, and the vacuum for the best working is not always the same in all tubes; the real determining factor appears to be the intensity of the electric force acting on the tube; other physicists believe that it is a question of the form rather than of the dimensions of the tubes; Righi believes it is the small dimensions and not the elongations which gives the maximum intensity with a higher pressure; he found that if the distance between the cathode and the anti-cathode is increased the pressure corresponding to the maximum intensity decreases. An illustrated description is given of a simple form of tube devised by Righi, which consists of a plain glass tube capped at one end with an aluminum thimble sealed with Spanish wax, while the other end is plugged with this wax, through which the terminal and a small glass tube for exhaustion passes, thus no glass-blowing is required; the thimble must be immersed in water to prevent the wax from melting; the pressure corresponding to the maximum intensity in this tube was found to be $\frac{1}{10}$ of a millimetre; to regulate the vacuum the tubes must remain connected with the pump. Colordeau obtained remarkably good results with a miniature focus tube, which is illustrated; it is 7 millimetres long, the diameter of the cylinder part being 6 to 7 millimetres; it gives images of great sharpness and practically instantaneous impressions. The metal tube of Davies (see *Digest*, Oct. 10) is illustrated, and is said to have a remarkable penetrating power; an effect on a phosphorescent screen was produced with such a tube 62 feet off. The highest intensity of the rays can be obtained only by using comparatively strong currents; S. P. Thompson found that heating the anti-cathode of a focus-tube to a visible redness increases the output very decidedly; it appears that the platinum salt is still the best material for phosphorescent screens, although the tungstate of calcium is much cheaper.

Röntgen-Ray Tubes. La Nature, Nov. 21.—An illustration showing a collection made by Seguy of 32 different forms of tubes which have been used ; it is accompanied by the names of the designer and by a brief discussion of the properties of each one of them. The tubes are divided into three classes, first those which were used as originally, in which the action is based on a direct radiation, in the second it is based on reflection and in the third on a combination of the two.

Fluoroscopy. Gariel. *Rev. Gen. des Sc.*, Oct. 30.—A long article on the direct application of the X-rays, showing the advantages of using the fluoroscope in preference to photographs ; it is accompanied by some excellent photographs taken mainly with Colordeau tubes, most of which, especially one of a living fish, are very clear ; it includes one of a fœtus and another of a two-headed child, showing two complete back bones and a union of some of the ribs.

Experiments with Röntgen Rays. S. P. Thompson. *Proc. Lond. Phys. Soc.*, October.—The beginning of a reprint of the paper noticed in the *Digest*, July 11.

Cathode Ray Spectrum. Poincare. *L'Eclairage Elec.*, Nov. 7.—A reprint of an Academy paper discussing the recent paper of Birkeland which was noticed in the *Digest*, Nov. 7, and in which the author described a phenomena resembling a spectrum when the cathode rays were subjected to the action of a magnetic field. An apparently paradoxical result was that the phenomena was not changed by reversing the poles of the magnet; this question is discussed mathematically in the present article in which it is shown that it can be explained without the use of any new hypothesis; it appears that in changing the poles of the magnet two quantities change sign, the result therefore being a deviation in the same direction.

Jaumann's Theory of Cathode Rays. Poincare. *L'Eclairage Elec.*, Nov. 7 and 14.—A long reply of a mathematical nature giving the theory of Jaumann and discussing it; although the theory in its present form is not accepted by the present writer, the experiments on which the theory is based are of great interest; he believes that Jaumann has drawn premature conclusions from his experiments; he then offers another explanation of the phenomena.

Photoelectric Effect of Cathode Rays. Elster and Geitel. *Wied. Ann.*, No. 11; noticed briefly in the Lond. *Elec.*, Nov. 20.—They describe the behavior of alkaline chlorides under the influence of cathode rays; they lose their phosphorescence, acquire a characteristic coloration and become photo-electrical and sensitive, enabling a cathode coated with them to discharge itself under the influence of light.

Passage of Electricity Through Gases Exposed to Röntgen Rays. J. J. Thomson and Rutherford. *Phil. Mag.*, November; a reprint of a B. A. paper.—They give the results of a study of the conduction of electricity through gases, and of the properties of the gases, when so treated; the apparatus is described and the results are given, the paper being quite long.

Idle Currents. Blondel. Lond. *Elec. Rev.*, Nov. 20.—An abstract of the article noticed briefly in the *Digest*, Sept. 12 (see also Sept. 26). It appears to be a good summary but seems to contain nothing new; he considers the subject from the supply company's point of view. A power factor numerically less than unity is not the criterion of the presence of a wattless current; such a current is one having the same periodic time as the E. M. F. and difference in phase by a quarter of a period; leading wattless currents are of small importance; he discusses chiefly the lagging kind; the standard to aim at is to have the current in phase with the generator voltage, for unless this is done the supply company and the consumer cannot both be pleased; to avoid trouble caused by wattless currents one should either use apparatus in which such a component is not necessary for its working or else find additional apparatus to counteract the effect; it is advisable to use synchronous motors whenever possible to counteract in part at least the evil effects of induction motors which are to be used when the starting with a load is the most important consideration. The effects of a lagging current on the generator voltage can be diminished by strongly exciting the field; the suppression of wattless currents and their effects are among the most important problems of the day; it is thought that the solution will be found in improvements in the generators and motors themselves.

Rotation of Dielectrics. Quincke. Lond. *Elec.*, Nov. 20; abstracted from the *Wied. Ann.*, No. 11.—Small spheres, cylinders, etc., of a dielectric substance in an alternating field take up a definite position across the lines of force, but in a constant field they rotate as soon as they are immersed in a dielectric fluid.

Dielectrics. Appleyard. *Proc. Lond. Phys. Soc.*, October.—A reprint in full with the discussion of the paper noticed in the *Digest*, June 20.

Absorption of Electrical Waves by a Thermal Bridge. Bryan and Barton. Lond. *Elec.*, *Elec. Rev.* and *Elec. Eng.*, Nov. 20; abstract of a Physical Society paper.—They describe experiments, the results of which confirm the theory and prove that by using a bridge of that description the reflected train of waves can be completely extinguished.

Communication of Electricity from Electrified Steam to Air. Kelvin, MacLean and Galt. Lond. *Elec.*, Nov. 20.—A brief B. A. paper in which it is shown that steam gave up a large part of its electricity to be carried away by the air.

Magnetic Field Due to Electrical Oscillations. Lecher. *Zeit. f. Elec.*, Nov. 15; a reprint of a short Austrian Academy paper.—In the well-known experiments of E. Thomson a wire ring is repelled by a coil through which an alternating current passes; the present writer determined the current induced in this ring experimentally in such a simple way that a theoretical calculation of the relations of the currents in the two circuits becomes possible; for this reason the frequency was made as high as possible and no iron was used. He at first determined experimentally the magnetic field around the coil by passing through the solenoid and the ring two opposite continuous currents whose relation was changed until they produced the same magnetic field, the calculations gave a surprisingly accurate agreement with the observed. The method is illustrated and the curves are shown; by determining a sufficient number of points he was enabled to draw the curves quite accurately; the results showed that the lines of force generated by the continuous current and those generated by the oscillations were identical; also that the number of lines of force was not altered by closing the secondary circuit. He used oscillating currents produced by the discharge of condensers.

Röntgen Streams. Tesla. *Elec. Rev.*, Dec. 2.—A long article in which he gives further arguments with reference to his theory that these rays are streams of some matter projected with great velocity from the walls of the tube; he also gives his views on other matters. The small particles may be ions formed by electrolysis, or comparatively large particles of the electrode, or perhaps molecules of the residual gas; he assumes an actual projection through the walls of the bulb; the matter which is projected is not a homogeneous stream, but consists of particles of varied magnitude moving with different velocities; it is therefore important to find a method of filtering them and rendering them homogeneous; the amount of matter is so minute as to escape detection; some bulbs which he had used for months showed that the bombarded spot was entirely permeated with particles of the aluminum electrode; a tube with an aluminum electrode does not lose its quality but seems to improve, whereas with platinum its life is very short. The location of metallic bodies in the bony parts of the human trunk is attended with difficulties, but he believes success will be invariably attained if the suggestions which he gives are strictly followed. He confidently expects the demonstration of a germicidal action; he believes that the injurious action on the skin has been misinterpreted and that it is not due to Röntgen rays, but merely to the ozone generated in contact with the skin; nitrous acid

may also be responsible for some of it; he therefore always guards the person with a screen of aluminum wires connected to ground through a condenser; a radical method would be to immerse the skin in oil; the action of ozone on some substances when placed near the bulb is so powerful that they are practically destroyed in a few minutes; he suggests the combination of nitrogen of the atmosphere on an industrial scale for the manufacture of fertilizers; he refers to the subject of making the blind see by means of X-rays, pointing out the hopelessness of it; means would have to be found for refracting the rays, for if not, only a shadow of a very small object could be projected on the retina; an effect on the optic nerve might be expected; he has not been able to confirm some of the reported experiments; he found that the impression is chiefly due to ordinary light. Regarding the best conditions when taking impressions he states that there are two elements, the bulb and the coil; the capacity of the former largely determines the voltage of the coil; at a certain exhaustion this capacity produces a maximum voltage which gives rise to the most intense rays, but it usually happens that the rays are then not the most abundant; both these causes should be made to co-operate by a careful proportioning of the dimensions of the bulb, or the use of a coil which contains no fine wire and is capable of giving a heavy current; the fluorescent screen should be made of such a material which becomes luminous by the faintest impact of the stream; there will be a certain velocity of the moving particles which will give the best definition, and this is easily found by trial; the most sensitive material and not that which fluoresces strongest is the one best suited for finer work. The best method is to first run the tube with a greatly reduced voltage and then gradually raise it until the shadow is the clearest, but as the vacuum then rises so does the pressure, and the image gets blurred although much brighter; just as the cleanness is slightly diminished the current should be reversed for a few moments and then used in its original direction again.

Penetrating Power of X-Rays. HAGA. *Am. Jour. of Sc.*, December.—A brief reference to a paper in which he showed the existence of several kinds of X-rays; at a high degree of rarefaction of penetrating power through flesh and bone is very different, so that the outlines of the bones are very distinct, while with less rarefaction these bodies transmit rays in about the same degree. Some observers think that the bones become phosphorescent and that therefore the field of view exhibits less contrasts. Fluorescent screens should not be phosphorescent.

Crookes and Geissler Tube Dust Figures. VILLARI. *Et'ty*, Dec. 2.—A reprint in part of the article noticed in the *Digest*, Nov. 21.

Magnetic Survey of Maryland. Elec. Eng., Dec. 2.—A brief account of the investigations which are being conducted under the direction of Bauer.

ELECTRO-CHEMISTRY AND BATTERIES.

Glycerine and Soda from Soap Lyes. GLATZ and LUGO. Lond. *Elec. Rev.*, Nov. 20.—A short note describing briefly their method. The soap lye which is left in the manufacture of soap represents a waste product; their process enables glycerine and caustic soda to be recovered from this soap lye by electrolysis. The anode is a plate of zinc or carbon in contact with the liquor under treatment; the cathode is in a porous pot; the current decomposes the caustic soda, forming sodium hydrate at the cathode; the glycerine is set free, while the albumenoid and coloring matters are rendered insoluble and are easily removed by filtration; after this treatment the insoluble matter is separated out and the liquor is distilled, forming a perfectly pure, clear glycerine; the caustic soda is practically pure and can be used by the soap maker.

Permeability Curves of Cast Steel for Dynamo Magnets. Lond. *Elec.*, Nov. 20.—A reproduction of the curves noticed in the *Digest*, Nov. 7, under "Dynamos."

Magnetic Field Due to an Elliptical Current. JONES. *Proc. Lond. Phys. Soc.*, October.—A reprint in full with the discussion of the paper noticed in the *Digest*, June 20.

Electrolysis of Fused Zinc Chloride. LORENZ. *Proc. Lond. Phys. Soc.*, October.—A brief abstract from the *Zeit. Anorg. Chem.*, 12, page 272.—He found that pure fused zinc chloride requires 1.5 volts to produce electrolysis while the calculated value is 2.1, the discrepancy being due to the differences in the temperatures.

Electrochemistry. KORDA. *Rev. Gen. des Sc.*, Nov. 15.—A reprint of his paper at the recent Congress of Applied Chemistry. He discusses aluminum, the electric furnace, metallic carbides, the electrolysis of chlorides and electric tempering.

Progress in Electrochemistry. Elek. Anz., Nov. 12.—A continuation of the summary noticed in the *Digest*, Nov. 14.

Electrical Convection Currents. RICHARZ and LONNES. *Proc. Lond. Phys. Soc.*, October; abstracted from *Zeit. Phys. Chem.*, 20, p. 145.—With a voltage too low for visible decomposition, a small current still flows through dilute sulphuric acid; they describe experiments which seem to show that most of this current is accounted for by the action of dissolved molecular oxygen and the rest probably by occlusion of oxygen and hydrogen in the electrodes.

Tests of McDonald's Battery. Lond. *Elec. Rev.*, Nov. 20.—The first part of an article discussing and criticising unfavorably some tests of these cells which consist of zinc in salt water and a copper spiral surrounded by coke in a porous cup containing sulphate of copper; a small cell three inches square is said to give four amperes at two volts for over 24 hours.

Accumulator. Elek. Anz., Nov. 5.—A note stating that Krecke has succeeded in making an extremely hard mass with high capacity by mixing lead oxide with tannic acid and albumen of glue or by mixing lead oxides with uric acid.

Direct Production of Electrical Energy. BLOUNT. Lond. *Elec.*, Nov. 20.—Abstracts of the article by Andreas which was noticed in the *Digest*, Nov. 28, and of the gas battery of Bucherer noticed in the *Digest*, Nov. 28.

Jacques Carbon Cell. REED. *Elec. Eng.*, Dec. 2.—A short article commenting on the one noticed in the *Digest* last week. With the data now published by the inventor there can be no further discussion as to the efficiency, the commercial utility depending entirely on the success of the details which the inventor says are yet to be worked out; the results are most encouraging if only the weight of the material consumed is considered. The data gives little, if any, assistance in arriving at a conclusion whether the action is galvanic or thermoelectric; the fact that carbon dioxide is formed and oxygen and carbon consumed, and that the theoretical voltage is obtained, is no indication that the action is not thermoelectric, but rather that it is; if the current corresponds exactly to the electrochemical equivalent, which seems to be the case, the answer to the question appears to be that the action is thermoelectric, and that the oxidation is due to the electrolytic action; in that case the energy of the carbon would be consumed in maintaining the E. M. F. on closed circuit, provided there is no reduction of hydrogen or metal, for if these pass out of solution the energy of the carbon will first supply that absorbed by the reduction, and the balance, if any, will go toward maintaining the E. M. F. on closed circuit; such an action will be very economical, but could not take place with the evolution of energy in an electrolyte consisting of pure caustic alkali, since the reduction of hydrogen or the alkali metal would absorb more energy than that contained in the carbon; if the carbon dioxide is produced in excess of the electrochemical equivalent there must be oxidation independent of the current, which cannot occur in the Jacques cell; if the action in the cell is galvanic, that is not a result of electrolysis; the chemical action will continue on the carbon after it is out of the circuit, that is, on the detached particles; the quantity of carbon consumed and of gas formed will therefore necessarily be greater than that corresponding to the current; if the action is thermoelectric and the chemical action a result of electrolysis, no carbon can oxidize after it has passed out of the circuit and the quantity of carbon consumed would then be the exact equivalent of the current. That the action is thermoelectric appears to be established by the results obtained by Jacques, which he shows by a quotation. The only satisfactory theory is that suggested by E. Thomson (see *Digest*, Nov. 28, under "Heat"); the electrolyte used satisfies either the thermoelectric or the galvanic theory, but the quantitative results appear to exclude the galvanic; the validity of the theory may be tested by using a silver crucible and caustic alkali free from iron and other impurities, a silver tube being in use for introducing the air; with this apparatus he ventures to predict that no electrical energy will be obtained from the consumption of carbon within the pot. Whatever be the theory it cannot detract from or add to the value of the discovery, if an efficiency of 32 per cent. is obtained.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Carbon Megohms for High Voltages. MORDEY. *Phil. Mag.*, November; a reprint of a short B. A. paper.—He points out the utility of inexpensive and trustworthy high resistance, showing that the ordinary carbon megohm cannot be trusted, as the delicate line of plumbago is disturbed too much by the heat generated; he therefore constructed others in which he increased the cross-section of the conducting film and correspondingly increased its length, thus obtaining a resistance which is practically unaffected by any ordinary variations of temperature and may be used with 100 volts per megohm; excellent results were obtained with long strips of shellaced cartridge paper coated on one side to a width of one or two inches with plumbago, well burnished, the edges of the strip being folded over the film to protect it; the strip is then rolled into a loose spiral secured to a support. Examples were shown, the resistance of one of which was 1.315 megohms at 74 degrees Fahr. and was practically constant up to 150 degrees Fahr.; another was subjected to 100 volts for 12 hours without showing any change.

Self-Testing Resistance Box. Lond. *Engineering*, Nov. 6.—An illustrated description of the resistance box and bridge devised by Callendar and Griffiths. It is stated that the designers have perfected the measurements of electrical resistance to a degree hitherto unattainable. The coils are of bare platinum-silver wire immersed in a common bath of hydro-carbon, so that they may all be kept at the same temperature, which can also be accurately measured; a binary scale of resistances is used, beginning with five ohms, each coil being double the preceding; the chief advantage of this is that the coils may be tested by the observer, as each should differ by a fixed quantity from the sum of those below it. There is a slide wire in connection with it, the vernier on

which reads to 0.00001 ohm; the thermoelectric effects are eliminated by means of Griffith's key; there is an ingenious form of contact maker for the bridge wire.

Resistances. Armagnat. *L'Eclairage Elec.*, Nov. 7, 14 and 21.—The beginning of a series of articles forming a sort of treatise on the subject; in the first portion he discusses mercury standards, showing there how they are constructed and filled, how the mercury is cleaned, etc. In the second portion he discusses resistance alloys, giving their properties and describing their use in resistance boxes, in which connection he discusses at some length the question of the heating of the coils so used; resistances for strong currents are also discussed. In the third portion he discusses the construction of resistance boxes and slide-wire resistances.

Galvanometers. Ayrton and Mather. *Phil. Mag.*, November.—A short article discussing and criticising some recent statements. Sir David Salomons, in a recent article on "Electric Discharge in a Magnetic Field" (see *Digest*, Oct. 3) showed that the sensibility of a d'Arsonval galvanometer is very small when the magnet is very powerful, and increases rapidly when the excitation is somewhat diminished, and considers this due to the Hall effect; the present writers show that it could not possibly be due to this effect, and call attention to the fact that the phenomena is well known, and that they had shown some years ago that it was due to the magnetism in the silk and other parts of the coil, which are usually considered non-magnetic; the purest copper wire still showed traces of a magnetic action; they have devised new coils which enabled the field to be four times as strong. They also replied to some of the statements of Holman in an article which was noticed in the *Digest*, Dec. 21, 1895, regarding the waste space near the needle in a galvanometer; that writer had criticised the present ones, but they claim that he was in error and would have arrived at the same conclusions had he considered the case correctly; several other errors are also pointed out which would modify his conclusions greatly.

Protecting Galvanometers from External Magnetic Influences. Raps and Franke. Lond. *Elec.*, Nov. 20.—A translation in abstract of the article noticed in the *Digest*, Oct. 10.

E. M. F. of Clarke Cell. Kahle. *Wied. Ann.*, No. 11; abstracted briefly in the Lond. *Elec.*, Nov. 20.—He describes the measurement at the Reichsanstalt by means of Helmholtz's electro-dynamometer and obtained 1.4488 volts at zero degrees and 1.4322 at fifteen degrees, using the H form of cell. The article seems to also contain a reference to a cadmium cell.

House Wiring Insulation Test. Russell. Lond. *Elec.*, Nov. 20.—A brief communication referring to the method of May (see *Digest*, Nov. 14 and Dec. 5) showing that it cannot give accurate results because the leakage from the mains and installations connected to them has not been considered; one should either determine independently the difference of potential between one main and the earth, or take the constant each time through a known resistance which is sufficiently high so as not to affect the relative potentials. Editorially it is stated that on three-wire network the error is usually not very great.

Method of Measuring the Temperature of Incandescent Lamp Filaments. Janet. *L'Ind. Elec.*, Nov. 11 and *L'Eclairage Elec.*, Nov. 14.—A reprint apparently in full in the latter journal and in abstract in the former, of the article noticed in The Electrical World last week, page 682.

Direct Measurement of the Frequency. Campbell. *Proc. Lond. Phys. Soc.*, October.—A reprint in full with the discussion of the paper noticed in the *Digest*, June 20.

Determining the Magnetic Elements at Sea. Guyou. *L'Eclairage Elec.*, Nov. 7.—A reprint of an Academy paper describing and discussing the methods which are used at sea.

Adjustment of the Kelvin Bridge. Appleyard. *Proc. Lond. Phys. Soc.*, October.—A reprint in full of the paper noticed in the *Digest*, May 23.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephone Trunk Line System in Great Britain. Gavey; concluded in the Lond. *Elec. Eng.*, continued in the *Elec. Rev.* and begun in the *Elec.*, Nov. 20.—A continuation of his Institution paper (see *Digest*, last week). He continues the discussion of the crossing of the wires on these lines; it is found in practice that disturbances which arise between neighboring twisted circuits can be eliminated by crossing systematically; by the simple method used it was found possible to make them absolutely free from overhearing. Hard drawn copper wire is universally used for trunk lines, varying in gauge from 100 pounds per mile to as much as 800, the object of the latter being to provide for connection with submarine cables; the resistance and inductive capacities of the various overhead wires used are given in a table; the capacity from wire to wire is 0.6 times that of the wire to earth; the use of underground wires for trunk lines was utterly impracticable with gutta percha, india rubber or like materials, but the air space paper insulation seems to have solved the difficulty; the capacity to earth in paper cables is 0.06 to 0.08 microfarad per mile with conductors of 20 to 40 pounds per mile and about 0.1 for 100 to 150 pounds per mile. A brief history of the trunk lines in Great Britain is then given and is followed by a somewhat detailed description of the general system adopted at the present time, and the method of working it; an illustrated description is given of some of the details and of the connections at a station; an automatic system of signaling is used in which the mere act of removing the telephone announces a call at the station, while the restoration of the telephone to its position sounds the closing signal; this is described in detail. The brief discussion contains nothing of interest; it is to be followed by a longer one at the next meeting.

Submarine Telephone Cables. Fitzgerald. Lond. *Elec.*, Nov. 20.—A communication stating that Mr. Preece should furnish much more information before it is possible to discuss the controversy between Preece and Heaviside; Preece stated that his object was to increase self-induction and decrease capacity, while Heaviside states that Preece's arrangements will do the reverse; the information which Preece gives about his cable is not sufficient; the capacity of a wire should mean the charge on it when raised to unit potential; when all other neighboring conductors are at zero potential; this accurate sense of the term cannot be the one meant by Preece. He thinks there is no serious difficulty in constructing a cable having 30 microfarads per nautical mile, with a considerably less self-induction than in existing cables, and he would do this by carrying out the principles laid down by Preece for diminishing the capacity and increasing the self-induction.

International Telegraph Charges. Jour. Telegraphique, Nov. 25.—A table of charges, published in the form of a supplement, for international messages as determined by the recent International Congress.

Telegraph Relay. MacDonald system. Lond. *Elec. Eng.*, Nov. 20.—A description by the inventor of his improved Morse relay, of which considerable notice was said to have been taken in the American press.

MISCELLANEOUS.

Protection of the St. Jacques Observatory from Lightning. Milde and Grenet. *L'Ind. Elec.*, Nov. 11 and *L'Eclairage Elec.*, Nov. 7.—A reprint of an Academy note explaining the system of protection of that tower in Paris, which, during a recent severe thunder storm proved to be very effective; it appears that there were five discharges of lightning sufficient to heat to redness the upper end of the rod for a distance of about half a metre; the observers perceived no physical effect; a system of double conductors was used so as to completely envelop the tower.

Electric Curling Iron Heaters.

Recognizing the demand for a safe and simple electric hair-curling appliance the American Electric Heating Corporation, Boston, is introducing an improved electric curling iron heater so constructed that it cannot be in circuit unless the tongs are inserted in the heater, when removed the circuit being automatically opened. The heater is made in nickel finish or polished brass mounted on polished marbleized base complete

Curling Iron Heater.

with cord and plug for attaching to lamp socket. The current consumption is about 50 watts. For hotel use they are mounted on marble or other bases arranged to screw to the wall. The illustration shows the general appearance of the device, which is a very attractive ornament and provides an electrical Christmas present for the electrician's best girl.

Paper Used in Place of Plates for Röntgen-Ray Work.

As the greatest development of the Röntgen ray has been in its application to surgery, so it is in this department that its limitations have been most seriously felt. The time required to develop and print from the negative before a convenient record of the results could be obtained, has seemed an objectionable feature of the work.

The flexible paper introduced by the L. E. Knott Apparatus Company, Boston, seems likely to overcome nearly all of the objections to the use of glass negatives. Since the exposure is made direct upon the paper no printing is required, and as the paper is transparent to the Röntgen ray any number of copies may be obtained at once by the superimposing process, and the record thus obtained cannot be broken. The paper may be made to readily comform to the shape of the part to be photographed. These, and many other advantages claimed for this paper, would seem to warrant its general introduction for this particular use.

Motor Cars on the Brooklyn Bridge.

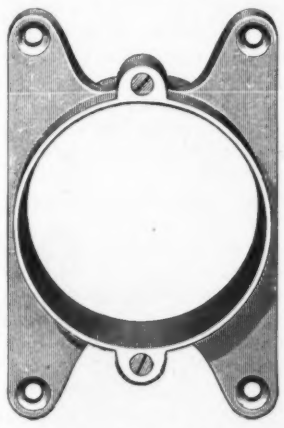
The switching of trains on the Brooklyn Bridge is now entirely done by electricity, the change having beene ffected on Nov. 30, when 12 motor cars were put into service, operating the trains in conjunction with the cables more quickly, quietly and satisfactorily than the steam motors. Fourteen motor cars are now in service and the remaining six car equipments are being installed as rapidly as possible, to be put into service as soon as completed.

The trucks are from the shops of the McGuire Manufacturing Company, Chicago, and were especially designed for this work. In these trucks the draft of the train is taken directly on the journal boxes instead of through a swinging bolster, the entire top frame having a sufficient lateral motion to cushion on curves. The weight of each truck is 10,000 pounds; wheel base 5 feet 6 inches. The equipment of each motor car consists of four G.E. 50 motors and two K 14 series parallel controllers—motors and controllers also being especially designed to meet the peculiar requirements of bridge traffic. The motors have the usual characteristics of all General Electric railway motors.

Beneath each platform is an automatic circuit breaker, which effectually prevents any injury to the motors from the sudden rush of currents. The breaker is set at 800 amperes, and should the current exceed this a latch is tripped by the action of a solenoid, and the conduits in the device are instantly separated, breaking the circuit. Additional protection is provided by cut-outs, also embodying the magnetic blow-out principle, whereby the arc formed at the disruption of the fuse is magnetically extinguished.

The circuit breakers take the place of the well-known main circuit hood switches, and are wired in multiple instead of in series.

With the motors, the heaviest bridge trains are readily hauled up the 3.78 grade, and during the early morning hours the motor-cars will handle the entire traffic of the bridge after the cable has stopped running. The motors will also help heavily-loaded trains up the grades and keep the grips from slipping the cable.



FLUSH SWITCH-POCKET.

The power to run the trains is taken from the Fulton Street feeder from the Kent Avenue station of the Brooklyn City Railway, the return-wire being connected to the rails of the surface road.

In the issue of THE ELECTRICAL WORLD of Nov. 7 last, was published a fuller description of this installation.

Flush Switch-Pocket.

Among the many improvements and additions to the extensive line of specialties manufactured by the Anchor Electric Company, of Boston, none will find more favor with the man who installs flush switches than the simple little piece of cast iron illustrated herewith. This flush switch "pocket" is made for single, double, triple, quadruple, and, in fact, any number of gangs, and will fit all the smaller sizes of Anchor switches.

They are sold at cost of manufacture for the accommodation of users of Anchor switches.

The Steel Motor Company's Series Parallel Controlling System and Railway Apparatus.

The car controlling devices of the Steel Motor Company, Johnstown, Pa., differ in many respects from those of other makes, and several of their distinctive features are meritorious in the highest degree. In the details of construction of the controller switches the difference is almost, if not fully, as great as in the means employed to effect the transition from the series to the parallel connection. The difference in the design can readily be seen by an inspection of the illustration of the interior of the controller presented herewith.

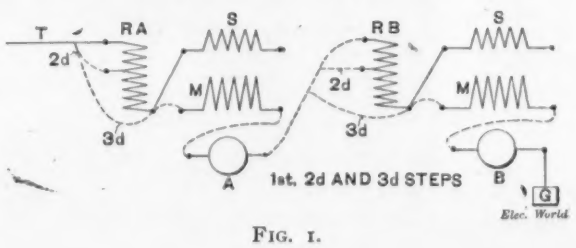


FIG. 1.

A feature of more than ordinary value in these controllers is that the reversing switch is used for the purpose of cutting out either motor. This arrangement not only displaces two cut-out switches, but, what is of far more importance, enables the motor man to cut out a motor by simply turning the reverse lever to the proper point; thus saving the time and trouble of removing the controller casing. When a motor is cut out, the remaining one can be run in either direction, and the mere moving of the lever to these points throws into action locking devices which prevent the movement of the controller switch beyond the steps that effect the series combinations. The operation of this combined reversing and cut-out switch will be explained further on. The operation of the controller proper is well illustrated by the five small diagrams, which show the combinations corresponding to the various steps or positions of the switch handle, and also two intermediate combinations between the fourth and fifth step and one between the fifth and sixth, by which the sudden increase in speed in passing from the series to the parallel connection, as well as the tendency to spark, are toned down.

The first diagram, Fig. 1, shows the connections corresponding to the first three steps of the controller handle. The second diagram, Fig. 2,

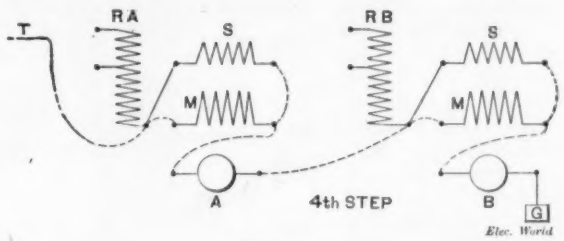


FIG. 2.

the connection on the fourth step. The third, Fig. 3, the changes effected in passing from the last series connection to the first parallel connection, which is reached on the fifth step, and is shown in the fourth, Fig. 4, diagram. This diagram also shows the connection for the sixth step and the one between it and the fifth, the seventh step being shown in Fig. 5.

In all the diagrams, *RA* and *RB* are the rheostats of the two motors, *S*, resistances through which a portion of the current is shunted from the field coils *M*, and *A* and *B* represent the armatures.

On the first step the trolley wire is connected with the entering end of *R A* and passes through this and the field coil *M* and armature *A* in succession and then through *R B* and the field and armature of the second motor. On the second step the speed is increased by cutting out a portion of the two rheostats *R A*, *R B*. A further increase in speed is effected on the third step by cutting out the remainder of the rheostats. On the fourth step the field coils are shunted by the resistances *S*, and thus a further increase of speed is effected, (see Fig. 6).

The fourth step is the last in the series connection, and in passing to the fifth, which is the first parallel connection, two momentary changes are effected. These are shown in Fig. 3, and are marked step *4 a* and *4 b*. In *4 a* the motor *A* is cut out of the circuit and left with all its terminals open as shown, the trolley wire going directly to the first terminal of *R B*. The step *4 b* connects the trolley wire with the second terminal of the rheostat *R B*. When the fifth step is reached the two motors are connected in parallel with all the rheostat *R A* in service and one half of *R B*. In passing to the sixth step all the resistance of both rheostats is cut out, *R A* being cut out half at a time, as will be explained further on, and on the seventh step a still higher speed is obtained by shunting the current around the fields of both motors through the resistances *S*.

The manner in which the controller switch accomplishes these results is as follows: When the switch is placed on the first step, the current coming from the lightning arrester enters the wire *T* and goes to the terminal *T* in the controller located below the switch, which is connected with the second finger of the reversing switch, counting from the top. From here it passes to the top finger of the controller switch and through the fourth contact from the top to the *1 A* finger, which leads to the entering terminal of the rheostat of motor *A*. By the wire *3 A*, the current passes from the end of the rheostat to the field of motor *A* and returns to the controller by wire *4 A* and through the connection between the cylinder contacts, passes to *6 A* and thence to the fifth finger of the reversing switch. This finger connects with the one next above through the switch cylinder, and thus the current finds its way to *6 A* of motor *A* which is one of the armature terminals. Returning by wire *7 A* the current goes to the sixth finger of the reversing switch and thence to the third finger, through the connection effected by the

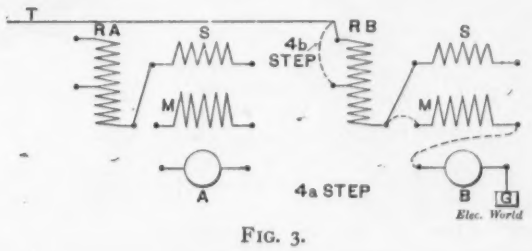


FIG. 3.

cylinder. The third finger connects with the *S C* finger of the controller, which is the second one from the bottom, and this is connected with the *1 B* finger, through the cylinder; thus the current passes to the entering end of the rheostat of motor *B* and by wire *3 B* to the field, from which it returns by wire *4 B* to controller finger *4 B*, and as this is connected with *6 B* through the cylinder, the current passes to the latter and on to the eighth finger of the reversing switch, which is connected with the ninth, which in turn connects with the terminal *6 B* of motor *B*, and this is one of the armature terminals. From the other terminal *7 B* the current passes by wire *7 B* to the seventh finger of the reversing switch, and as this is connected with the tenth finger through the cylinder, the current goes to the latter and thus to ground.

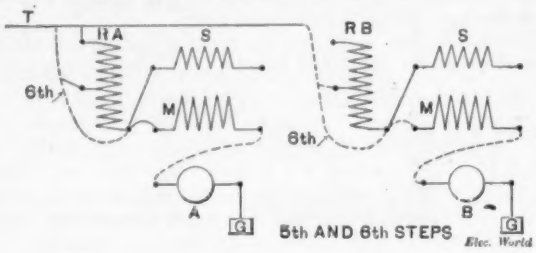


Fig. 4.

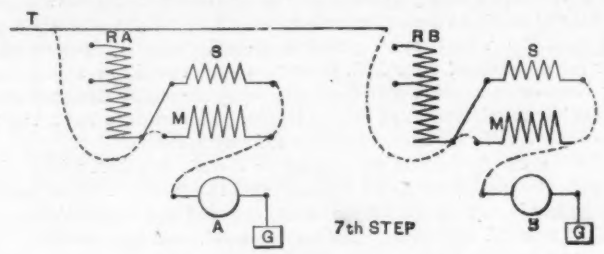


Fig. 5.

When the switch handle is moved to the second step the current follows the same course as before until it reaches the top, or trolley finger of the controller; then instead of passing to finger *1 A*, as on the first step, goes to finger *2 A* through the contact on the cylinder, which in this position runs under it. In this way the first section of the rheostat of motor *A* is cut out. The current then follows the same path as on the first step until it reaches the *S C* finger of the controller, and from this it passes to finger *2 B*, which in this position slides onto a contact on the cylinder that connects with *S C*, as will be seen from an inspection of the diagram. By this means the first section of the rheostat of *B* motor is cut out. From here to ground the path is the same as on the first step.

On the third step the current follows the same path as on the second, except that when it reaches the trolley finger of the controller it passes to *3 A* and thus cuts out all the rheostat of motor *A*, and when it reaches the *S C* finger it passes to *3 B* finger, thus cutting out all of the rheostat of motor *B*.

When the fourth step is reached, two extra connections are made by the controller cylinder that serve to close shunt circuits around the field coils of the two motors. By looking at the diagram it will be seen that the *5 A* finger of the controller will run onto a contact piece at the fourth step, and that this contact is connected with those in line with *4 A* and *6 A*. It will further be seen that *5 A* leads to one end of the shunt resistance, which is shown directly under the rheostat, the other end of this shunt being connected with wire *3 A*; therefore, when the current passes from the trolley finger to *3 A* it will follow this course until it reaches the junction of wire *3 A* and the end of the shunt resistance, which is effected by the connection of both of these wires with the end of the rheostat, as is clearly shown in the diagram under motor *A*. The current flowing through the field will return to finger *4 A* of the controller as before; and that going through the shunt resistance will return to finger *5 A*, which is now connected with *4 A*. The two currents will then unite and continue on through *6 A*, in the same path as on the third step, until the junction of wire *3 B* with the end terminal of the rheostat of motor *B* is reached, and from here will again pass through two paths, one through the motor field and the other through the shunt resistance, the first current returning to the controller finger *4 B* and the second to finger *5 B*. From here to ground the path is the same as third step.

From the foregoing it will be seen that the two fields are shunted by the contacts between the fingers *5 A* and *5 B* with cylinder contacts shown on the fourth line between *4 A* and *6 A* and between *4 B* and *6 B*.

In passing to the fifth step two intermediate connections are made, the object of which is to graduate the change from the series to the parallel connection so as to not increase the speed with a jerk, and also to obviate excessive sparking. The first change effected is to cut out motor *A* as is shown in the small diagram *4 a*, and it is accomplished as soon as the cylinder has revolved far enough to break contact between the fingers *3 A*, *4 A*, *5 A*, *6 A*, *3 B*, *5 B*, *S C* and the cylinder contacts upon which they rest when on the fourth step. These breaks cut out motor *A* and leave it with all the terminals open, as shown in the small diagram *4 a*. Immediately following the breaks just mentioned, a connection is made between the trolley wire and the entering end of the rheostat of motor *B*, by the finger *1 B* passing onto a cylinder contact. As the handle is moved further the finger *2 B* rides over a contact which is connected with the trolley contact, and thus the first section of the rheostat is cut out. On reaching the fifth step contact is restored between the cylinder and the fingers *1 A*, *4 A*, *6 A* and *4 B*, *6 B*, *S C* and in addition the lowest finger on the cylinder is brought into use, and serves to ground the armature terminal *7 A* of the motor *A*, which runs to the finger *S C*. As the connection between the cylinder plates may not be as clear as might be desired it will be well to say that the two lowest ones, that is *S C* and G, are connected with each other and disconnected from all the rest, and the next three, *6 B*, *5 B*, *4 B*, are also connected with each other and isolated from the rest.

An inspection of the diagram will show that when the fifth step is reached the motors will be connected in parallel, since the fingers *1 A* and *2 B* will be resting on cylinder contacts that are connected with the trolley finger contact, and thus the current can pass direct to the entering end of the rheostat motor *A*, and the second, or middle contact, of the rheostat of motor *B*. The current after passing through the motor *A* goes to ground through the connection between the cylinder contacts upon which the fingers *S C* and *G* rest, and the current through the motor *B* passes to ground by way of the seventh and tenth fingers of the reversing switch, as explained in connection with the first step.

In passing to the sixth step both rheostats are cut out, that of motor *A* by the passing of finger *3 A* onto a cylinder contact connected with the trolley contact and motor *B*, by the passing of finger *3 B* onto another cylinder contact connected with the trolley contact. On the fifth step all the rheostat of motor *A* is in service, and as it would not be desirable to cut in the whole resistance at once in passing back from the sixth step, an intermediate combination is introduced, by which finger *2 A* makes contact first and this is immediately followed by the finger *3 A*. On the seventh step the two motor fields are shunted, by connections effected between the cylinder and finger *5 A* and *5 B*. The course of the current with these connections is the same as was explained in connection with the fourth step and therefore will not be repeated here.

In the foregoing the direction of the current through the system has been given when the reversing switch is on the first step, which runs the motors in the forward direction. When the reversing switch is moved to the second step the motors will be reversed, the necessary changes in the direction of the current being effected as follows: After the current has passed the rheostat and field and returns to the fifth finger of the reversing switch it will pass to the sixth finger instead of the fourth, as

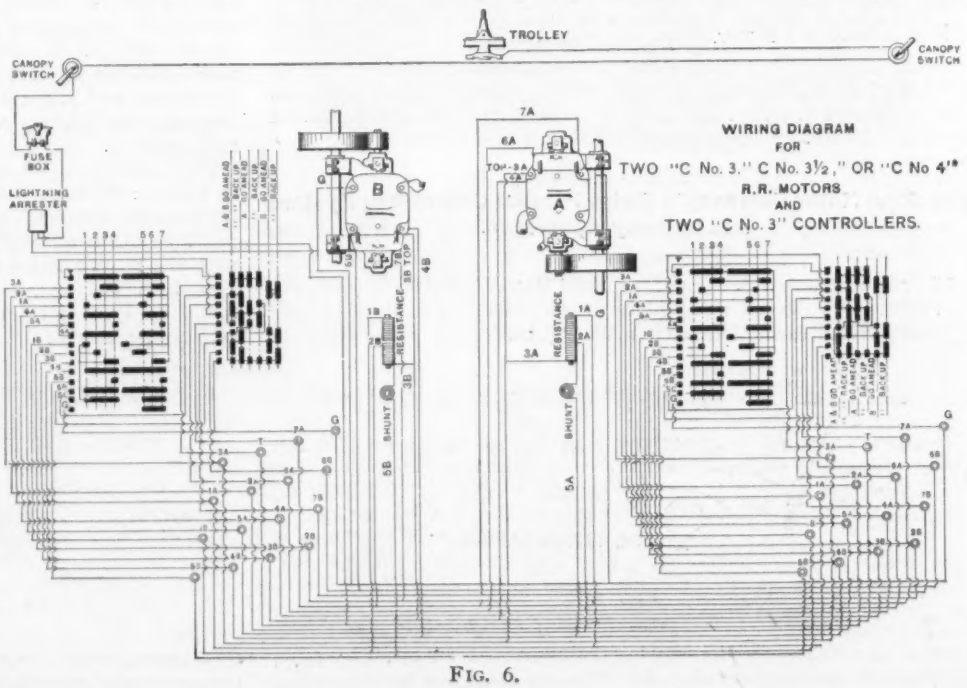


Fig. 6.

was the case on the first step; this will send the current through the armature by way of *7 A*, whereas before it went by *6 A*; hence the direction of the current through the armature of motor *A* will be reversed. The current will then follow the same course as on the first step until it reaches the eighth finger of the reversing switch, and here it will pass to the seventh finger instead of the ninth, thus reversing the current through the armature of the motor *B*. The third and fourth fingers of the reversing switch will be connected, thus passing the current from *6 A* to *S C*, instead of from *7 A* to *S C*, and the ninth finger, which connects with *6 B*, will be connected with the tenth, which is grounded.

When the reversing switch is moved to the third step the motor *B* will be cut out and the other one will go ahead, the change in the connections being as follows: The fourth and fifth fingers will be connected as on the first step, and the sixth one which connects with *7A* will be connected with the tenth, and therefore with ground, the current then will go to ground after passing through the motor *A*. The third, seventh, eighth and ninth fingers of the reversing switch will be disconnected and thus cut the motor *B* clear of the line, at all points.

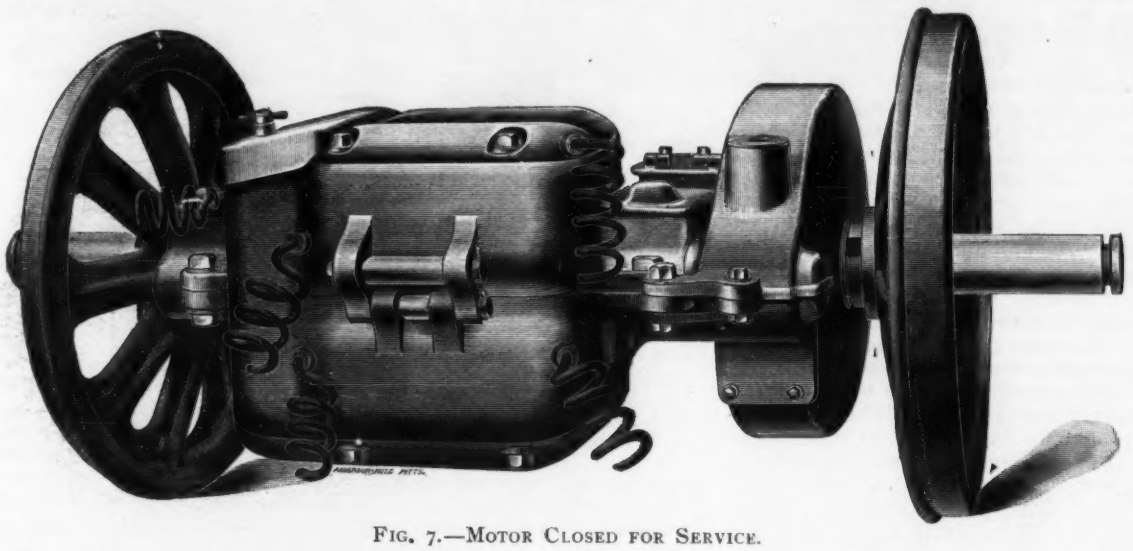


FIG. 7.—MOTOR CLOSED FOR SERVICE.

FIG. 8.—INTERIOR OF CONTROLLER.

On the fourth step motor *B* is still cut out and motor *A* is reversed, and to accomplish this it will be seen that the fingers that are in use are the same ones as in forward motion, but that their connection with each other is the same as on the second step, which gives the reverse motion when the two motors are in service. The only difference between the connections on the first and second steps and on the third and fourth is that in the last two the fingers that connect with the motor *B* are disconnected, but those that remain in contact are connected the same in both cases.

The fifth and sixth steps of the reversing switch cut out the motor *A* and run the motor *B* in either direction, and here again it will be seen that the fingers that are used are connected the same at the lower end of the switch; that is, the fifth and the first steps are the same and so are the second and the sixth. At the top of the switch, however, there is a difference, the second finger which connects with the trolley wire coming from the lightning arrester does not connect with the top finger which connects with the trolley finger of the controller, but with the third finger, which connects with the *S C* finger of the controller, and this is really the beginning of the circuit of the motor *B*. The change in the arrangement at the top of the switch is necessary to disconnect the motor *A* from the trolley.

In addition to the new type of controller above described, the Steel Motor Company, Johnstown, Pa., has been for the past two years actively engaged in the manufacture of motors, controllers and every device pertaining to electric car equipments. From the beginning its apparatus was well received, as it embodies some of the most advanced ideas in electric railway equipment.

The company manufactures a 30, a 40 and a 60 hp motor. In general appearance these motors are very similar, their only difference being that in the more powerful motors a slightly heavier frame is used and the field magnets and armature are appropriately wound for the additional output. The actual rating of any of the motors by no means limits the load which can be carried for brief intervals.

In Fig. 7 is shown a view of the motor as it appears when ready for service. This machine is of the ironclad type, in the manufacture of which the Steel Motor Company claims to be the pioneer. The frame of the motor is of low-carbon steel and, of course, has all the qualities of lightness which are common to magnets constructed of that material. The bearings for the car axle and the armature are of the same casting and therefore are always in line, and the gears are always in accurate mesh. The top and bottom of the motor frame are secured to the bearings by bolts, and they together with the field coils may be removed by simply loosening the bolts. The frame is parted in the centre and the lower half may be swung downward as shown in Fig. 9. The armature

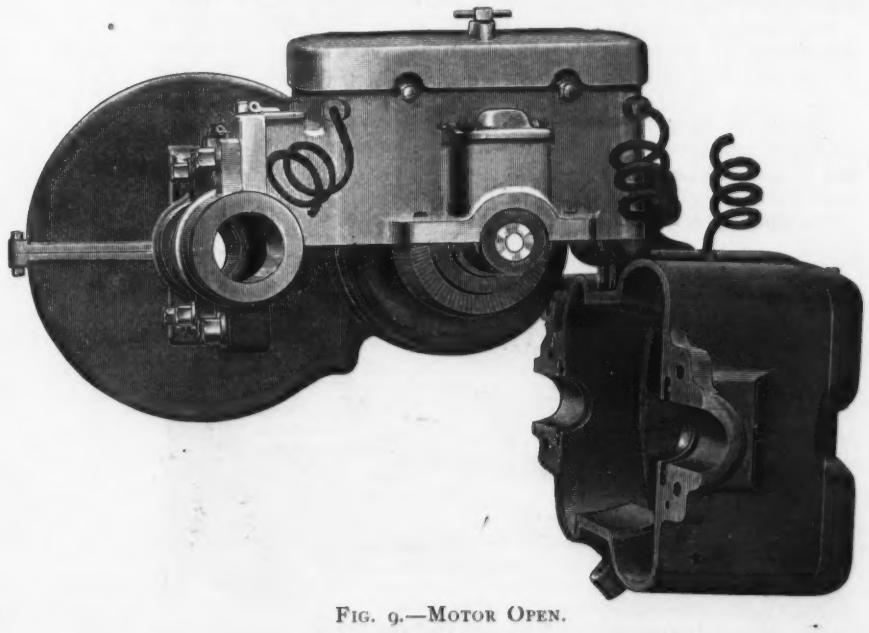


FIG. 9.—MOTOR OPEN.

may remain with the upper half or be swung down with the lower half, at pleasure.

Access to the commutator may be had without disturbing any other part of the motor, by simply lifting the little lid shown at the right of Fig. 7.

The bearings are of phosphor-bronze and are lubricated with grease. The covers of the grease cups are of malleable iron and are secured by springs, thus effectually excluding dirt. In the lower half of the bearings is a slot adjacent to the internal casing of the motor which deflects the surplus grease through two channels on the outside of the motor casing, thus preventing grease from reaching the windings. The armature core is of the toothed type and is built up with thin discs of Swedish iron, the heads being of soft steel. The discs and head are pierced with holes parallel to the shaft, for ventilating purposes. The winding is of the drum type with machine-formed coils which are slipped onto the core of the armature. The coils are taped beforehand and insulated with troughs of a special insulating material. The heads are covered with canvas, and the pinion end of the armature is protected by a brass shield slotted with holes for ventilation. The coils are laid in place and secured with German silver wire. The commutator and pinion are put on tapered seats, and hence are easily removed, but nevertheless are securely held in place. Lateral motion is prevented by means of powerful nuts. The commutator shell is of malleable iron, and the copper segments are drop-forged and insulated with the best quality of India mica. The leads from the armature coils are insulated with specially prepared tubing, and attached to the commutator segments by slotting. The field coils are wound upon brass spools and are therefore free from the danger of chafing. The common method is to simply tape the coil, and unless it is very securely held in place, the continuous jar to which the motor is subjected will soon wear a hole in the insulation and cause a ground in the electrical circuit.

The brush holders are independently adjustable, and have a very uniform pressure on the commutator. The tension of the pressure spring is uniform throughout the life of the brush. The axle gear is of cast steel, and both gear and pinion are cut from solid metal. The gears are cased in and run in oil.

Adjustable Incandescent Lamp Shade.

Where a strong light is desired to cover a limited area, such, for instance, as lighting desks, typewriters, pictures, pianos, etc., "The Klemm" adjustable shade is admirably suited.

For close-by work strong reflected light is preferred, as it does not blind the eyes as does the naked, direct light.

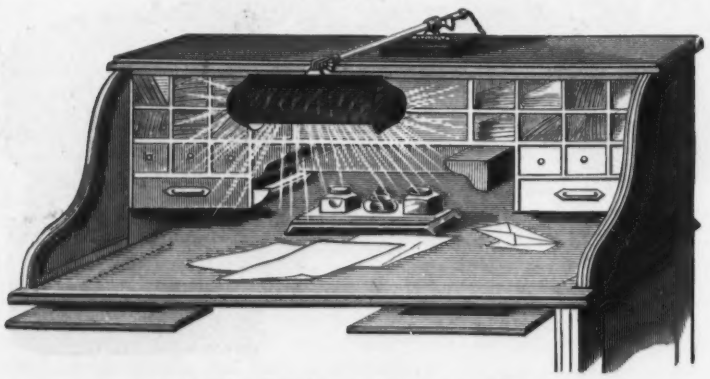
The adjustable shade herewith illustrated is manufactured and sold by Klemm & Co., 132 North Fifth Street, Philadelphia, Pa. The firm, however, does not confine itself to this particular style alone; it makes a great variety of reflectors for electric light, suitable for lighting and ventilating churches, halls, theatres, stores, etc. Its reflectors are claimed to be constructed upon scientific principles and have a reputation for quality.

Among the many designs of reflectors, the one illustrated will probably appeal strongly to the attention of the busy man, for it is at his desk or table that he does his work, and there is where he wants plenty of light.

The shade for rolling top desks is shown. It has a bright corrugated reflector on the inside. It is adjustable so that the light can be thrown in any direction, at the same time shielding the eyes from the direct rays.

One great advantage possessed by this device is that it can be readily attached to any electrical fixture by means of flexible cord and can be placed at any angle and its position changed by merely giving it a twist.

The same idea is carried out in a portable stand, which is designed



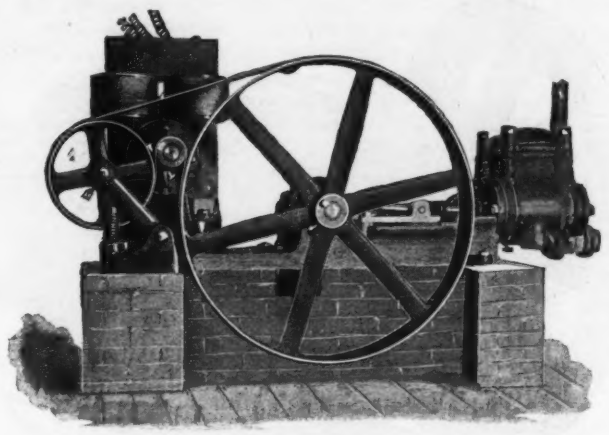
Incandescent Lamp Shade for Desk.

for flat top desks or tables. The reflector of this style is as well adjustable to any angle.

These reflectors are mounted with polished brass fittings, the outside of the screen itself being finished in green or bronze. The reflecting surfaces consist of corrugated polished metal which reflects a strong but mellow and pleasant light.

Electric Pump.

A new and simple form of electric pump, intended to supply the deficiencies of city water pressure in high office buildings, residences, etc., has just been placed on the market by the Commercial Electric Co., Indianapolis, Ind. The motor and pump are secured to the same bedplate, the apparatus being entirely self contained. In place of the usual gearing an endless belt is used, an idler controlled by a spring serving to



Electric Pump.

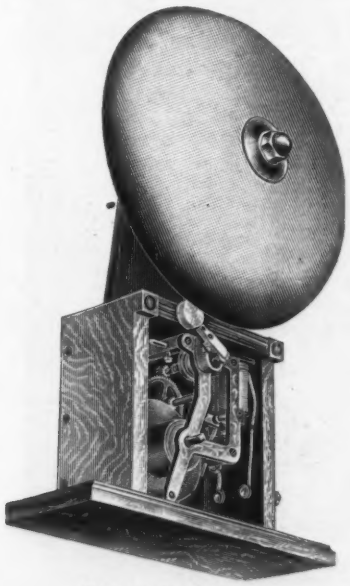
preserve a constant tension. By this means the disagreeable rumble of gearing, which is hardly avoidable even when the best is used, is entirely obviated. The pump is carefully and substantially made and has ample adjustments for wear. The motor is a special, low-speed type and runs very quietly. These pumps are made in five sizes, ranging from a capacity of 500 gallons per hour to 1800 gallons per hour.

Electro-Mechanical Gong.

The new electro-mechanical gong, manufactured by Edwards & Co., 144th Street and Fourth Avenue, New York City, differs in some points from those types now on the market. The hammer is pivoted at the post and when released it makes a full revolution, passing under the gong. It is raised by an inclined plane, strikes the gong a powerful, clear blow and drops to its normal position under the gong. After the first blow the armature remains close to the magnets, so that very little power is required for its operation, and very rapid blows may be struck.

The smaller sizes, four to eight inches, are encased in a polished wood box, with a nickel-plated front, to which is attached the entire mechanism of the bell. By unscrewing this front the whole bell may be removed from the case and the inner parts exposed. Lantern pinions and a very strong spring encased in the main spring box are used.

The larger sizes, 10 to 30 inches, are mounted on a cast frame and entirely encased in a polished wooden box, the front of which can be



Improved Gong.

removed as shown in the cut. The wheels are cast bronze, and the pinions of solid steel. This style is made to operate by either a spring or weight, and will strike about 500 blows to each winding.

These bells can be arranged to continue striking single rapid blows until the circuit is broken.

Being dust and damp proof they may be used in exposed places.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Dec. 5, 1896.

ELECTRICAL STOCKS.—There was no marked activity in the market during the week just past, although an evident stronger feeling obtained. What few changes in quotations that are recorded were in an upward direction. Edison Illuminating Company of New York shows advance of 1 point to 100½; electric Storage Battery closed with a gain of ¾; General Electric closed at an advance of ⅝ over last week's closing price and Westinghouse preferred closed with a gain of 1½.

TELEGRAPH AND TELEPHONES.—Commercial Cable and Postal Telegraph are the only two stocks that show any noteworthy improvement. The advances no doubt were one of the results of the closer business alliance effected between the two companies during the week just past. Commercial Cable stock closed at a price 10 points above the last week's final quotation, and Postal shows an improvement to the extent of 2 points. Bell telephone lost ½ point, while Erie telephone advanced 2¼ as compared with the previous quotation. Western Union closed at the same figure quoted last week.

ELECTRIC TRACTION stocks were fairly strong but quiet during the week, Brooklyn City continuing to be the most active security on the list. Worcester Traction suffered a loss of 1 point, probably an effect of the reports of decreased earnings. The advances are as follows: Baltimore Traction, ½; Brooklyn Rapid Transit, 1; New Orleans Traction, 1; West End, preferred, ¾. The losses were Buffalo Street Railway, 1; North Shore Traction, 1; Union Railway (Huckleberry), 2, and Worcester Traction, 2.

THE COMMERCIAL CABLE COMPANY has declared a dividend of 1¾ per cent., payable on Jan. 1.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has declared a quarterly dividend of 1¾ per cent. on its preferred stock, payable on Jan. 1 next.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	..	..
Edison Electric Ill., New York	100	100½	104
" " " Brooklyn	100	88	93
" " " Boston	100	..	..
" " " Philadelphia	100	..	..
Edison Ore Milling	100	7½	10
Electric Storage Co., Philadelphia	100	28¾	29¼
Electric Storage, pref	100	30½	51
General Electric	100	32½	33
General Electric, pref	100	70	..
Westinghouse Consolidated, com	50	25	..
" " pref	50	51½	..
BONDS.			
Edison Electric Ill., New York	105	105½	..
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	92½	..
TELEGRAPH AND TELEPHONE.			
American Bell Telephone	100	208½	209
American District Telegraph	100	*29	39
American Telegraph & Cable	100	90	91½
Central & South American Telegraph	100	124	127
Commercial Cables	100	160	172
Erie Telephone	100	66¾	67
New England Telephone	100	100½	..
Postal Telegraph-Cable	100	92	94
Western Union Telegraph	100	86½	86⅝
ELECTRIC TRACTION STOCKS.			
Baltimore Traction	25	18	18¼
Brooklyn Rapid Transit		21	21¼
Brooklyn Traction	100	..	14
" " pref	100	46	48
Buffalo St. Ry	100	76	78
Cleveland Electric Ry	100	..	..
Columbus St. Ry	100	43	45
Hestonville	100	51	52
" pref		..	62½
New Orleans Traction	100	12	14
" " pref	100	42	46
North Shore Traction	100	22	25
" " pref	100	75	78
Rochester St. Ry	..	17	20
Steinway Ry	..	45	50
Union Railway (Huckleberry)		98	102
Union Traction, rcts $10 pd	..	12¾	13
West End, Boston	100	66	..
" " pref	100	87½	..
Worcester Traction	100	18	20
" " pref	100	92	95
BONDS.			
Brooklyn Rapid Transit 5s, 1945	100	77	..
Buffalo St. Ry. 1st con. 5s	100	*107	..
Cleveland Elec. Ry. 1st mtge 5s	100	100	*103
*Columbus St. Ry. 1st 5s	100	95	100
Rochester St. Ry. 1st 5s	100	..	98
Union Railway (Huckleberry) 1st mtge 5s		*101½	103
*Westchester Electric 1st mtge 5s	100	100	103

* With accrued interest.

THE NORTH SHORE TRACTION COMPANY, in its September report, shows gross earnings of $131,782, a decrease of $9,846 as compared with the same month last year, and net earnings $65,953, a decrease of $28,735. The gross earnings for October were $111,826, an increase of $4959 over the gross earnings in October last year. Net earnings during October this year were $44,844, an increase of $5,598.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Dec. 7, 1896.

MR. E. CATE, of the L. E. Knott Apparatus Company, Boston, Mass., made a call at THE ELECTRICAL WORLD office on Monday last. This company is meeting with much success and its specialties possess merit and interest.

HENRY ELECTRICAL SOCIETY.—The 63d meeting of the Henry Electrical Society was held at 111-115 West Thirty-eighth Street, New York, on the evening of Dec. 4. Prof. F. B. Crocker lectured on the subject "The Principles of Electro-Chemistry," and illustrated his remarks by experiments.

THE JOHN STEPHENSON COMPANY.—It is reported that the car shops of the John Stephenson Company of this city will be moved to Elizabethport, N. J., where a new plant will be built. The reason for this change is that there is not enough space in the present quarters for the proposed extension of the plant.

TO BE PROTECTED FROM COLD.—The electrical contractors of this city will not hereafter require their employees to work in buildings that have not glass or sheeting to protect the workmen from the cold in the Winter time. It is stated that under this new arrangement better and quicker work will be possible. The electrical workers will on Jan. 1, 1897, demand an increase of wages from $3 to $4 per day, and have notified the contractors that they may be prepared for it.

BALL OF THE EMPLOYEES OF ZIMDARS & HUNT.—The third annual ball of the associated employees of Zimdars & Hunt, the electrical contractors, 127 Fifth Avenue, this city, was held in Lyric Hall on Sixth Avenue on the evening of Dec. 1. As usual on these annual occasions the stage and hall were very brilliantly decorated with electric lights. Some of the designs were very artistically wrought and produced a very pretty effect when lighted up. There was a large attendance and a very enjoyable time was had.

TELEPHONE INSTALLATIONS.—The Wilson-Bates Electric Company, 136 Liberty Street, New York, has installed 359 telephones in the new St. Paul Building, at the corner of Broadway and Park Row, and 300 instruments in the new Bowling Green office building at the foot of Broadway. In each of these buildings the local telephones will be connected with the bureau of information situated near the main entrances. Ericsson transmitters will be used in both installations in connection with ordinary watch-case receivers. A motor dynamo plant is now being installed in the St. Paul Building for the operation of the telephone system.

BULLET IN THE BRAIN LOCATED BY MEANS OF RÖNTGEN RAYS.—Mr. E. B. Meyrowitz, 104 East Twenty-third Street, this city, on Dec. 2, for the purpose of locating a bullet which had been fired into the skull of George Appo three years or more ago, exposed Appo's head to Röntgen rays. The result of the experiment, it is stated, was successful and the location of the bullet distinctly visible on the photograph plate. For this case a specially prepared focus tube was used and Appo's head was exposed to the action of the rays for a full hour. Appo is an inmate of Bellevue Hospital and is being held for the purpose of inquiry into his sanity. He was a witness for the Lexow Committee.

ELECTRICAL SUBWAYS IN BROOKLYN.—The Board of Commissioners of Electrical Subways of the City of Brooklyn has issued its report covering the period beginning Dec. 15, 1895, and ending Oct. 31, 1896. The report shows the amount of work done under the supervision of the commission, and its presentation at this time is due to the fact that the life of the commission terminates by law on the date last mentioned. Since June, 1892, when the Board began its work, 180 miles of conduit containing 280 miles of single duct have been constructed. The railway companies have done much during the year to keep the return currents on the path of their own conductors, so that the injury is doubtless much less rapid than it was two years ago.

HEAVY DAMAGES CLAIMED FOR DEATH BY LIGHTNING STROKE.—A novel and interesting case will be tried in the Supreme Court during the present month. During a storm last July Louis K. Brown took shelter in a store in White Plains, N. Y., sitting in front of the telephone which hung on the wall. A stroke of lightning entered the building by way of the telephone wire and instantly killed Brown. Brown's father instituted a suit against the New York Telephone Company, claiming $20,000. He alleges that the telephone company was negligent in that the telephone was not properly put in, and that there was no ground wire attached to the lightning arrester. He also claims that no cut-out plug was furnished with the instrument.

WESTINGHOUSE DIRECTORS.—At a meeting of the directors of the Westinghouse Electric & Manufacturing Company, held in New York on Dec. 2, the offices of general manager and assistant general manager were abolished. Mr. Lemuel Bannister was appointed first vice-president in charge of the commercial department; B. H. Warren, second vice-president, in charge

of the manufacturing department, and P. F. Kobbe, third vice-president, in charge of the financial department. The membership of the Executive Committee was increased to four, and Mr. G. W. Hebard, formerly vice-president, was made a member of the committee and empowered to act as vice-president in case of absence or inability to act of any of the vice-presidents.

THE ELECTRICAL TRADES SOCIETY OF NEW YORK held its first annual meeting on Dec. 4. About two thirds of the members were represented. The report of the chairman of the Electrical Committee was most encouraging. It showed the steady growth of the society, the good work it is doing and the promising outlook for the future. From the report of the treasurer it was found that the society already has a snug little sum in the treasury for future contingencies A number of instances were given of the beneficial results already accruing to members for the interchange of information regarding customers. After the adoption of permanent constitution and by-laws, and the election of a new Executive Committee for the ensuing year the meeting adjourned.

POSTAL TELEGRAPH AND COMMERCIAL CABLE INTERESTS.—The directors of the Postal Telegraph-Cable Company and of the Commercial Cable Company met Dec. 1 to take action in regard to forming a closer alliance. The relations of the two companies will not be changed except that they are to be bound closer in organization by the absorption of Postal stock by the Commercial Cable Company. The latter will give in exchange for the Postal stock a debenture or collateral trust bond, dollar for dollar, and guarantee 4 per cent. The capital of the Postal Company is $15,000,000 with no bonds; the Commercial Cable Company's capital is $10,000,000, no bonds. This closer alliance is formed for the purpose of continuing in perpetuity the co-operative working of these two companies. The stock of each company at present is held by practically the same interests, so that in this respect the new arrangement will make no change. A meeting of the stockholders of both companies has been called for Dec. 22, to ratify the action of the directors.

MUNICIPAL OWNERSHIP OF EVERYTHING.—An organization is being formed in Brooklyn to forward the agitation of the question of the municipal ownership of gas, electric lighting and other industries of a semi-public nature. Mr. Edward M. Grout has written a letter to the Greater New York Charter Commission, in which he discusses the subject at length. He suggests that in specifying the powers of the Municipal Assembly of Greater New York, a section be added which will authorize that Assembly to submit to a popular vote at any time the provision that the city acquire or construct and operate gas or electric light works and street railways, either surface or elevated, either in whole or in part, and in case of a favorable vote to provide for the necessary steps to accomplish the result. Mr. Grout refers to the successful operation of similar ordinances in various European cities, and states that, as applied to gas works, uniformly excellent results have been experienced in many of the cities of the United States. As applied to electric lighting, he states "not less than 100 municipalities in this country already own and profitably operate their own plants," and cites the experience of Detroit, Mich., as a notable example of the advantages of municipal control of electric light plants.

PHILADELPHIA NOTES.

Branch Office of THE ELECTRICAL WORLD,
927 Chestnut Street,
PHILADELPHIA, Pa., Dec. 5, 1896.

VALLEE BROS. & CO., formerly at 617 Arch Street, have, owing to a large increase in their business, been obliged to move into more commodious quarters. Their new place, 625 Arch Street, has a frontage of 34 feet by 165 feet deep with a three-story building in the rear. With these enlarged facilities, they will be enabled to fill orders more promptly than ever.

JAMES J. MURRAY & CO., of this city, who are the pioneers in the manufacture of shades for electric light purposes, report that their business has increased to such an extent that they will soon enlarge their plant, which is already one of the largest in the country. They have recently gotten up some new designs in arc and incandescent globes and shades of various shapes, clear and colored.

WESTERN NOTES.

Branch Office of THE ELECTRICAL WORLD,
936 Monadnock Building,
CHICAGO, ILL., Dec. 4, 1896.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY, Chicago, reports that it has received favorable letters and congratulations from its own patrons and many of its competitors for the good work accomplished as a result of the Watson patent victory. The company does not seem to care one way or the other as to the result of the Berliner patent suit now before the Supreme Court, claiming that its apparatus is the only telephone system free from patent infringement, this fact having been declared by the United States Patent Office officials.

THE BERLINER SUIT.—In a letter from Mr. J. E. Keelyn, president of the Western Telephone Construction Company, Chicago, that gentleman takes exceptions to the deductions of Mr. E. F. Frost in the latter's article on the Berliner suit, which was published in THE ELECTRICAL WORLD of Nov. 21. Mr. Keelyn thinks that Mr. Frost's "conclusions are apt to lead the public into a fear that the Berliner patent is to be sustained sufficiently to prevent the use of telephone instruments of the microphone type." He states that the records and briefs in the case appeal to him as having sufficient substance to make a much stronger case for the Government than appears from the oral arguments. He thinks the Supreme Court will be divided; "that not less than four judges will be of the opinion that the Berliner patent should not be sustained sufficiently to be dangerous;" and "that others may be affected by legal technicalities which did not strike Judge Carpenter as sufficient." Mr. Keelyn states that the public need have no fear as to the outcome of this case, as it will not be so far-reaching as to give the Bell Company the monopoly in microphone transmitters. Evidence is at hand, he states, that will show the patent to be worthless. Mr. Keelyn assures the public that in case a suit is brought against his company or its patrons by the Bell Company, the Berliner patent will be surely defeated.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, Nov. 25, 1896.

LOW TEMPERATURE RESEARCH.—Profs. Dewar and Fleming have opened their Winter campaign at the Royal Society in electrical research at low temperatures, by the measurement of the magnetic permeability of liquid oxygen and liquid air, and I may say that their results, when published, will be of great interest, as fully bearing out the unique magnetic position of liquid oxygen. Measurements, I understand, have also been made of the dielectric constant of liquid air.

STREET ARC LIGHTING.—The St. Pancras Vestry, which has for some time past set the example of lighting the main streets of its district by arc lamps, now proposes to make considerable extensions. Hitherto the arc lamps have been run off special continuous-current machines in parallel-series, each series comprising about 16 lamps. It is now proposed that the existing lamps and all future extensions shall be placed alternately upon the three-wire network, and upon the high pressure network, with a view of preventing the sudden extinction of the light in any given street, mishaps which have occurred somewhat frequently in the St. Pancras district.

BRISTOL.—The Bristol Tramway Company has decided to double the track mileage of this system, and is asking for power to work the extensions by electricity. There is, however, some doubt as to whether the matter will go through, since the Bristol municipality, which owns an alternate-current central station, is being urged by an influential section of its members not to give its sanction to the tramway extension unless the Tramway Company binds itself to take all the current required for the cars from the municipal central station. This is one of the many instances showing that the financial success of a municipal venture is not always compatible with "the greatest happiness of the greatest number."

"THE ENGINEER" 1100 GUINEAS ROAD CARRIAGE COMPETITION.—In its last issue *The Engineer* again publishes the conditions of the above competition. The judges are to be Sir Frederick Bramwell, Mr. John Audley, F. Aspinall and Dr. John Hopkinson. The competition is to be international. The vehicles will be divided into four classes, and one supplemental class, in each of which a prize will be given as follows: (A.) For the best mechanically-propelled vehicle constructed to carry, including the driver, four or more persons, the total weight when fully loaded not exceeding two tons, a prize of 350 guineas. (B.) For the best mechanically-propelled vehicle constructed to carry either one, two or three persons, the total weight when fully loaded not exceeding one ton, a prize of 250 guineas. (C.) For the best mechanically-propelled vehicle constructed to carry, in addition to the driver, not more than one ton of goods or parcels, the total weight when fully loaded not exceeding two tons, a prize of 250 guineas. (D.) For the best mechanically-propelled vehicle constructed to carry, in addition to the driver, 5 cwt. of goods or parcels, the weight when fully loaded not exceeding one ton, a prize of 150 guineas will be given. A supplemental prize of 100 guineas is offered for a spirit motor car. The judges are to have the power to divide any prize in case of vehicles proving of equal merit. At least two vehicles in a class must complete the whole journey, or no prize for that class will be given. Entries are to be made on printed forms, to be obtained at the offices of *The Engineer*, at any time prior to 6 p. m. on the last day of March, 1897, being forwarded by registered letter, addressed to the editor of *The Engineer*, 93 Norfolk Street, Strand, W. C., and accompanied by a deposit of £1 for each entry, this deposit to be forfeited if the vehicle entered is not submitted for competition. The competing vehicles must be delivered at the Crystal Palace between the hours of 10 a. m. and 6 p. m. on some day in the week prior to the 24th of May next. The practical working run will consist of a run on the public roads of not less than 100 miles out and 100 miles home, or a total of not less than 200 miles, over a course to be announced three days prior to that fixed for the run. It is impossible at present to fix the exact date for this run, but it will probably be arranged for Monday, the 31st day of May next. Any vehicle that does not complete the practical working run at a minimum average speed of five miles an hour, to include all stoppages, shall be disqualified. As the attainment of high speeds is not one of the objects sought, it has been determined that nothing in speed over 10 miles an hour will be placed to the credit of any competitor, but subject to this condition the competitors may go as they please, at any speed they think proper, running continuously day and night, or stopping, as they think best. The following are the points which will be taken into consideration by the judges in awarding the prizes: (a) Distance run without taking or receiving supplies, etc.; (b) suitability of design and excellence of workmanship, not only of the actuating machinery but of the carriage; (c) safety; (d) simplicity, durability, accessibility and facilities for repair, absence of offensive smell and of excessive vibration; (e) time occupied in getting to work and ease of starting; (f) speed, up to 10 miles an hour, and hill-climbing; (g) completeness of control by and certainty and decision of steering and steering gear, and efficiency and durability of brakes and brake power; (h) weight of carriage and motor machinery and appliances; (i) first cost and—to a limited extent—the cost of working; (j) general efficiency.

CANADIAN NOTES.

MONTREAL, CAN., Dec. 4, 1896.

CHATHAM, ONT.—The Council will purchase an electric light plant.

SARNIA, ONT.—People of Point Edward and Sarnia are agitating for an electric railway.

GALT, ONT.—An electric railway is proposed to connect Brantford, Port Dover, and Galt, Ont.

EMBRO, ONT.—An attempt is being made to secure the installation of an electric light plant here.

ST. JOHN, N. B.—Steps are being taken to organize another electric lighting company in this city.

HALIFAX, N. S.—There is an agitation on foot to place all telephone and electric light wires underground.

OTTAWA, ONT.—The Ottawa Electric Light & Power Company has declared a dividend of 4 per cent. for the first half year.

SHAWVILLE, QUE.—An electric light plant will likely be installed here. The town is offering a company 20 years' exemption from taxation.

BRIDGEBURGH, ONT.—A by-law will be submitted to the ratepayers at the January elections to grant an electric light franchise to Mr. D. A. Cost.

MIDWAY, B. C.—Incorporation will be sought by the Cascade Water Power & Light Company for the purpose of supplying light, water and power to Midway, Anaconda, Greenwood, Grand Forks and Cascade City.

TORONTO, ONT.—The Toronto & Suburban Street Railway Company has been granted an extension of time to complete its line to Islington, until July 1 next. It is anticipated that a new power house will be erected at that point.

OTTAWA, ONT.—Application will be made for incorporation of a company to construct a railway from a point at or near Wabigoon, to the mining camps. The projectors are Toronto capitalists who propose utilizing water power to generate electricity. The road will be 75 miles in length.

General News.

New Incorporations.

THE HAWLEY ELECTRIC LIGHT & POWER COMPANY, Hawley, Pa., has been formed with a capital stock of $50,000.

THE KISKIMENETAS VALLEY TELEPHONE COMPANY, of Apollo, Pa., has been incorporated by C. W. Bollinger, Ira C. Ewing and W. H. Ewing. Capital stock, $2,000.

MERRITT ELECTRIC COMPANY, Boston, Mass., has been formed with a capital stock of $9000. The incorporators are H. I. Pettingill, E. W. Cushing, and Mathew Merritt.

THE DENVER TELEPHONE COMPANY has been incorporated by F. G. Beck, Charles Wheeler, B. B. Brown, N. S. Chamberlin and S. N. Jacobs. Capital stock, $500,000.

THE QUAKERTOWN TRACTION COMPANY, Quakertown, Pa., has been incorporated with a capital stock of $100,000. Mr. C. Taylor Leland, of Newton, is president of the company.

THE COLORADO ELECTRICAL & MOTOR COMPANY has been incorporated at Denver, Col., by George W. Russell, Jr., Z. H. Sherart and Frederick Robbins. The capital stock is $5000.

THE NORTHEAST ELECTRIC RAILWAY COMPANY, Kansas City, Mo., has been formed by S. M. Jarvis, R. R. Conklin, New York, and Baylis Steele, Kansas City. The capital stock is $250,000.

THE INTERSTATE TELEPHONE COMPANY has been incorporated at Tuscola, Ill., with a capital stock of $50,000. The incorporators are Albert W. Wallace, Samuel S. Goerhring and John T. Todd.

THE ASTORIA ELECTRIC LIGHT, HEAT & POWER COMPANY has been incorporated at Astoria, Ill. The incorporators are George Scripps, Winter Scripps and John D. Atkinson. Capital stock, $12,000.

THE CASWELL ELECTRIC COMPANY, Portland, Me., has been incorporated with a capital stock of $150,000. Those interested are T. E. Eaton, of Boston; Byron S. Caswell and W. H. G. Rowe, Winchester, Mass.

THE SANTA ROSA & SONOMA COUNTY ELECTRIC RAILWAY COMPANY, San Francisco, Cal., has been incorporated by N. W. Griswold, R. H. Warfield, John L. Boone, John F. Bixbee and Jesse B. Fuller.

Electric Light and Power.

OWINGVILLE, KY.—Owingville is figuring on the erection of an electric light plant.

NORRISTOWN, PA.—The Norristown Electric Light Company will erect a new plant.

LITTLE FALLS, N. Y.—The Little Falls Electric Light & Power Company and the Little Falls Gas Light Company have been consolidated.

HEMPSTEAD, TEX.—Col. W. H. Dickerson, of this city, is receiving subscribers for electric lights. The plant is to be put in by Col. L. A. Ellis.

BEDFORD, O.—On Dec. 12 a special election will be held in this place on the question of issuing $10,000 worth of bonds to cover the cost of an electric light plant.

BALLARD, WASH.—At an adjourned meeting of the City Council it was decided to buy an electric light plant. The city voted for a bonded debt of $51,000 for a water system and an electric light plant. The city will advertise for bids at once.

CHIPPEWA FALLS, WIS.—Owing to the flood in this place caused by the backing up of the water due to an ice gorge, the gas and electric plants were abandoned a few days ago, leaving the city in darkness as a consequence.

WASHINGTON, D. C.—At the recent annual meeting of the stockholders of the United States Electric Lighting Company, the Board of Directors was authorized to expend $300,000 during the coming year to secure the latest improved machinery for the generation of current and extend the services of the company.

NEW ORLEANS, LA.—The receivers of the Louisiana Electric Light Company desire to purchase additional machinery and apparatus for the extension of the plant in their charge, and with this object in view applied to the United States Circuit Court for permission to issue certificates for the purpose. The application was granted.

DES MOINES, IA.—The power plant of the Des Moines Water Power & Electric Company, together with all the machinery, appurtenances, etc., was sold at sheriff's sale on Nov. 24, to satisfy the judgment rendered against the old company. The purchaser was the General Electric Company, and the price paid was $83,708.04. The General Electric Company, it is stated, now has a monopoly of the lighting business in Des Moines.

NEW ORLEANS, LA.—Judge Pardee, of the United States Court of Appeals, on Nov. 20 signed a decree authorizing the sale of the property of the Louisiana Electric Light Company. The United Electric Securities Company is the chief holder of the stock and will purchase the property. It is stated that this company has already agreed to and signed a contract with the New Orleans Traction Company, by which the latter company is to have deeded to it, for its half million dollars of stock, one half of the plant, thus giving a perfect separation of the two interests. The traction company will set up its own establishment and supply its own power.

Telegraph and Telephone.

JANESVILLE, WIS.—The long-distance telephone line between Madison and Janesville has been completed and is now in thorough working order.

GALESBURG, MICH.—The Kalamazoo Telephone Company has extended its lines to this point and greatly reduced the rates as compared with those charged by the long distance service.

ASHLAND, KY.—A company with a capital stock of $35,000 will be organized to build a telephone line from this city to Webbville, Ky., and connect with a service covering several countries in this part of the State.

DETROIT, MICH.—The Detroit Telephone Company expects to open its exchange about Jan. 1. All of its wires between Third Street and Woodward Avenue and Elizabeth Street and Putnam Avenue will be placed under ground.

GRAND RAPIDS, MICH.—The Citizens' Telephone Company has completed its line between this city and Muskegon, and everything is working satisfactorily. The circuit is metallic, and connections have been made with all the intermediate towns.

KING CITY, MO.—The Council has granted a franchise to the King City, St. Joseph & Northwestern Missouri Telephone Company, and work will be soon begun to extend the line from Helena to this city. The line will be extended to the surrounding towns as early as practicable.

WAYNESVILLE, ILL.—The Waynesville Telephone Company has let the contract for the construction of its proposed lines from Waynesville to Tabor. At the latter place connection will be made with the Logan County Telephone Company's system and other local exchanges in this part of the State.

NEWPORT, R. I.—The City Council has granted the Providence Telephone Company the right for seven years to place its wires under ground, with exclusive use of the streets so used. For this franchise the city is to receive 1 per cent. of the company's gross receipts and other privileges. The company will not increase its present schedule of rates.

OMAHA, NEB.—The Nebraska Telephone Company has completed its line from Blair to Lyons. This gives the company 50 miles of line from Blair and 90 from Omaha. The company expects to have the line completed to Bancroft in a few days, and work will be commenced immediately on the extension from Elmira to Tecumseh, a distance of 40 miles.

The Electric Railway.

PLATTSBURG, N. Y.—The Plattsburg Traction Company has been granted the right to build, maintain and operate an electric street railway on Court Street in Plattsburg.

BRISTOL, PA.—The Philadelphia & Bristol Electric Railway Company is determined to extend its line to Bristol and Trenton. To this end it has secured a right of way to Morrisville.

EAST ORANGE, N. J.—The residents of the southern end of East Orange have decided to form an organization to secure a trolley road up Central Avenue from Newark. Andrew Baigrie was chairman.

BANGOR, ME.—A New York syndicate will begin at once the construction of an electric railway from Bangor to Winterport, to eventually run to Kenduskeag and East Corinth, making a railway 40 miles long.

TIFFIN, O.—Mr. Clark Rude, who is interested in the proposed electric road from Sandusky to Bellevue, Monroeville and Norwalk, has secured the right of way over the greater part of the route of the proposed lines.

CHARLESTON, S. C.—At the meeting of the City Council a petition was received from the Enterprise Railway Company asking for permission to go through other streets, and to be allowed to equip the line with electricity.

WATKINS, N. Y.—The officers of the Elmira & Seneca Electric Railway Company announce that the proposed electric railway between Watkins and Horseheads, to connect with the Elmira & Horseheads road, will surely be built now.

CHICAGO, ILL.—The General Electric Railway Company has filed a trust deed to secure $3,000,000 of bonds floated through the house of J. Pierpont Morgan & Co. The mortgage will cover the entire system and franchises of the General Electric Railway Company of Chicago.

BALTIMORE, MD.—The Baltimore County Commissioners have approved of the plans of the Baltimore & Gunpowder Railway, and passed an order authorizing the company to begin the work of laying its tracks and building a bridge over the Gunpowder River at the boundary line between Baltimore and Harford Counties.

SEATTLE, WASH.—The entire property of the Seattle Consolidated Street Railway Company was sold on Dec. 1 under foreclosure, for $139,601, to satisfy

the claim of the first mortgage bondholders. The property consists of 35 miles of roadway, rolling stock, power-house, etc., and the collapse of the company caused heavy financial loss to prominent Seattle capitalists.

SYRACUSE, N. Y.--The Railway Commission has granted permission for two important electric railways to be built in the vicinity of Syracuse, and work will be begun as soon as possible. Twelve miles of road are to be constructed by the Syracuse & Suburban Railroad from South Salina Street, Syracuse, to the village of Manlius, and a road is to be built from the Onondaga Lake Railway from Onondaga Lake to a connection in Syracuse.

PITTSBURG, PA.—The employees of the Consolidated Traction Company held a meeting a few days ago to consider the matter of the reduction in wages of the men employed on the Penn Avenue line. The committee waited upon General Superintendent Greenwood and presented their complaints. Superintendent Greenwood informed them that he would restore the wages of the Penn Avenue employees to the original rates until the directors of the company should meet and take further action in the matter.

Legal Notes.

RECEIVER APPOINTED.—Judge Dallas of the United States Circuit Court on Nov. 30 appointed William B. McGiven, of Columbia, Pa., receiver of the Pennsylvania Traction Company, of Lancaster County, Pa. The application for the receivership was made by George A. Lee of New York, and other bondholders, owing to the default of interest.

TO SETTLE ITS AFFAIRS.—The affairs of the Alexandria Bay Electric Light & Power Company are near settlement. Judge Hiscock, of Syracuse, has granted an order confirming the report of the referee, George S. Hooker, discharging the temporary receiver, Arthur E. Hume, and directing the permanent receiver, Andrew C. Cornell, to make distribution of the moneys in his hand in the manner directed in the referee's report.

DECISION AGAINST THE WESTERN UNION.—On Dec. 2 the District Court of Appeals at Washington, D. C., reversed the decision of the lower court in the case of Joseph Fererro, plaintiff and appellant, against the Western Union Telegraph Company. The suit was brought to secure damages for an alleged incorrectly written telegram from a business house in New York. One of the most important points decided was whether the receiver of a message could secure damages, and the decision of the court is said to be the first on the question rendered in the district. The Court of Appeals holds that the telegraph company is liable. The error which forms the cause of complaint was in the substitution of the figures 55 for 45 cents, being quotations on potatoes. An order was given on the basis of 45 cents, but before disposing of the consignment Fererro learned that the price was 55 cents and not 45 cents, and he refused to accept the goods. He brought suit against the telegraph company for damages for the loss he sustained through the error. Judgment was originally rendered for the defendant, but Judge Shepard in reversing the decision of the lower court, held that the plaintiff ought to recover the actual pecuniary damages that he might have sustained through the failure to obtain the potatoes at the price which he had reason to suppose they had been offered to him.

Obituary Notes.

MR. GEORGE F. BOTTOM, electrical inspector for the City of Kansas City and Board of Fire Underwriters, Kansas City, Mo., died recently at the home of his foster-father at Fletcher, S. D. The deceased was 36 years of age, and had been a resident of Kansas City for the past 14 years.

MR. F. G. PRATT, who for the past three or four years had charge of the catalogue department of the General Electric Company, at Schenectady, N. Y., died Nov. 7. Mr. Pratt was born at Keene, N. H., 36 years ago, and was a graduate of Harvard. His first electrical position was with the Boston & Albany Railroad, but owing to failing health he had to give this up and go South. He was afterward with the Union Switch & Signal Company, and while in this position invented and patented several valuable devices. In 1892 he entered the employ of the General Electric Company, and shortly afterward took entire charge of the catalogue department. His special aptitude and the breadth of his technical knowledge, extending as it did not only into the purely catalogue work, but also over the patent and engineering branches of the electrical business, peculiarly fitted him for the duties which fell to him. Any one acquainted with the vast amount and variety of the printed matter and special information which the operation of such a large company necessitates and the perfect shape in which it issues from the press, will realize the responsibility which rested on Mr. Pratt's shoulders. Mr. Pratt was universally esteemed, and his death will be a source of grief to all who knew him.

Personal Note.

PROF. PHILIP LENARD, who is well known through his experiments with cathode rays, has taken the chair of the Professor of Theoretical Physics in the University of Heidelberg.

Trade and Industrial Notes.

THE BETTS MACHINE COMPANY, Wilmington, Del., has issued a neat pamphlet describing its extension boring and turning mills. These machines are finding an increasing use and favor with the manufacturers of metal-working machines, tools for locomotive, car and bridge shops and machine works generally.

THE HENRY R. WORTHINGTON COMPANY, New York, manufacturer of pumping machinery, has just received word through its London office that the exhibit of Worthington pumps at the Hungarian national exhibition at Budapest has been awarded a grand millennium medal. This medal is said to be the only award made for pumping machinery at the exhibition.

MESSRS. STAUB & CORBETT, contractors, Belle Vernon, Pa., are ready to receive bids for a 500-hp steam plant complete, arc apparatus for 150 nine and one-half ampere arc lamps and an alternating-current incandescent machine of 3500 lights capacity. At present they may be addressed at Belle Vernon, Pa.; after Dec. 20, at Owensboro, Ky., where the plant is to be installed.

THE ST. LOUIS CAR WHEEL COMPANY, St. Louis, Mo., is out with a catalogue of its street car wheels and axles for electric motors, cable and horse cars. Each page is printed in the form of an order, with blank spaces for the dimensions, and the object of the plan is to tear out the perforated leaf and forward it filled in to the company, who will give prompt attention to orders so received.

THE CAMBRIA IRON COMPANY, Philadelphia, and Johnstown, Pa., has issued a catalogue of its T and girder rails. It is in two volumes, Vol. I. being devoted to T-rails and Vol. II. to girder rails. The books are bound in boards, and give much valuable engineering information besides that on the main subject. Diagrams are given of all the various sizes and types of T and girder rails made by this company, the dimensional details being given in each.

THE CENTRAL ELECTRIC COMPANY, Chicago, is engaged in the preparation of an "X-ray" catalogue, which is about ready for distribution. Considerable care and time have been devoted to the production of this work, and it will be replete with illustrations and descriptions of Röntgen ray experiments. The Central Electric Company is manufacturing Röntgen ray apparatus which is said to have attained the highest degree of perfection in its development and results.

THE ELECTRA Nuernberg carbons continue to make friends. Mr. Hugo Reisinger, 38 Beaver Street, New York, who supplies them to the trade, recently received the following letter from a prominent electric lighting company: "Please enter the enclosed order for carbons, to be of the celebrated 'Electra' brand. The shipment furnished us was so far superior to anything heretofore used by us, that we have concluded to adopt the 'Electra' carbons exclusively for our arc lighting in the future." This letter certainly shows that the 'Electra' carbons are held in high regard. Mr. Reisinger says that the large orders he is receiving even more indisputably demonstrate the good opinion of the trade.

THE D. M. STEWARD MANUFACTURING COMPANY, of Chattanooga, Tenn., is profiting by the increased activity in the electrical field. The company manufactures lava insulators and also lava parts for arc lamps and wherever heat has to be resisted. The lava insulator is absolutely fireproof and has been used with great success for many years for electrical purposes. President Steward reports an almost phenomenal growth in his business. In fact, the sales during October were the largest in the history of the company.

THE BRYANT ELECTRIC COMPANY'S NEW WESTERN FACTORY.—Regarding the decision of the Bryant Electric Company to establish a branch factory at East Liverpool, O., mention of which was made in the last issue of THE ELECTRICAL WORLD, the company states that it is not its intention to manufacture its complete line of supplies at East Liverpool, but for the present will confine its work at that point to Sawyer-Man cut-outs, 500-volt railway blocks and the well-known kilowatt ceiling rosettes. The manufacture of other specialties will be added as necessity demands. The Bryant Company will establish no business office at East Liverpool, and all correspondence should be addressed as formerly, either to its Western office at Chicago, or the main office at Bridgeport, Conn.

MESSRS. J. H. AND ROBERT B. McGOWAN, of the John H. McGowan Company, manufacturers of pumping machinery for all classes of service, Cincinnati, O., have just completed arrangements at Richmond, Va., for the extension of their company's business at that point. The company's branch house in Richmond will be moved into more commodious quarters in a modern building in the centre of the city, where the largely increasing trade can be better taken care of. In the new quarters the company will carry in stock a line of high-grade pumping machinery of the types usually installed in water-works plants, and will extend its supply department in order to cater more fully to the supply trade. After Jan. 1, 1897, it is the intention of the company to carry a large line of pipe, steam, gas, plumbers' supplies, etc.

THE P & B PRODUCTS, manufactured by the Standard Paint Company, 81 John Street, New York, are still enjoying large and increasing sales and are making many new friends. This company has steadily discouraged the use of any inferior material, and has in consequence maintained a high reputation for the excellence of its goods. A good cheap coating that gives a fine, glossy finish, flows freely and is very penetrating, can be supplied to those who desire it, but it is not the regular P & B compound. A new pamphlet setting forth the merits of the various P & B products, armature varnish, insulating tape, motor cloth, etc., has just been issued and will be sent to any one requesting a copy. Samples of the various materials will also be forwarded to street railways, electric light companies, engineers and others who desire to make practical tests.

WOOD SPLIT PULLEYS.—The Reeves Pulley Company, Columbus, Ind., in a circular referring to the decision of Judge Sage, of the United States Circuit Court at Cincinnati, concerning the interchangeable wood bushing and compression fastening patent, states that the decision does not apply to the Reeves Pulley Company, its agents or users of its pulleys. No decision, it states, has ever been rendered against that company. To the contrary, Judge Woods, in the United States Circuit Court, at Indianapolis, in 1892, decided in a suit then tried that the Reeves pulley did not infringe the Dodge patents, and in the appeal this decision was sustained. The Reeves Pulley Company, which is represented in New York by Patterson, Gottfried & Hunter, stands ready to protect all in the unrestricted sale and use of "The Reeves" wood split pulley.

A MANUFACTURING PLANT FOR SALE.—A splendid opportunity is afforded any manufacturing concern desiring to obtain a complete manufactur-

ing plant or extend an existing one, in the offer of the assignee of H. E. & C. Baxter, Brooklyn, N. Y. The plant includes machinery, special tools, patterns, goodwill, etc., and is particularly adapted for the manufacture of a large line of standard electrical goods. This concern was for several years engaged in the trade, but by reason of the hard times misfortune overtook it and it is now proposed to close out the business entirely. The firm enjoyed an excellent reputation in the electrical trade and produced a line of goods that met with much favor. The plant which is offered for sale is at Bedford, Canton and Division Streets, Brooklyn, N. Y., and Mr. James N. Baxter is the assignee. While the misfortune of the firm is regrettable, the opportunity offered for some one to buy the plant is one that will no doubt be eagerly competed for.

THE ENCLOSED ARC *VS.* SUNLIGHT.—It is stated that one of the great commission houses down town while testing various makes of arc lamps preparatory to placing a large order decided in favor of the "Pioneer" enclosed lamp, although from the results of their first comparative test, which was made in the daytime, they were strongly in favor of the open arc. It appears that the enclosed arc and the open arc were placed side by side, and both simultaneously turned on for comparison, the principal salesman of the department and the engineer being the judges of the illumination. The test was made at about 3 o'clock in the afternoon, in a portion of the store which was darker than the rest, but to which the daylight had free access. The decision of the judges almost without exception was in favor of the open arc. It was then suggested that another test be made after dark, when artificial light was really needed. This latter was carried out, and on this second test the decision of the judges without exception was reversed by giving the enclosed arc preference over the open arc.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 67–71 Park Place, New York.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, 105 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED DEC. 2, 1896.
[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

572,108. EAR-PIECE FOR TELEPHONE RECEIVERS; De W. C. Farrington, Washington, D. C. App. filed April 3, 1896. In combination with a telephone receiver, an ear-piece having a centrally disposed auditory passage, a cushion seated in and covering the face of said ear-piece, and having a central aperture coincident with said passage, and a detachable tubular section forming a continuation of said auditory passage and snugly fitting within the aperture of the cushion, so as to close the same and aid in holding the cushion to its seat.

572,124. INSULATED JOINTS FOR LIGHT FIXTURES; W. McElroy Brooklyn, N. Y. App. filed July 26, 1892. An insulated joint comprising two tubular metallic sections, one above the other, an insulating material between said sections for insulating them, having an aperture affording communication between said sections, in combination with a tubular metallic lip traversing said aperture in said material in intimate contact with the walls of said aperture, said lip preventing inward distortion of said insulating material, affording a passage through the joint, and discharging the drop therethrough near the centre of the lower section.

572,158. ELECTRIC SIGN; W. Connell, Pittsburg, Pa. App. filed March 10, 1896. In an electric sign, the combination of a sign-board having its surface covered with incandescent lamps and a switchboard having its surface covered with exposed circuit-terminals, there being one terminal corresponding to each lamp, the corresponding lamps and terminals being directly connected electrically and occupying the same relative positions on their respective boards, and a movable figure or character of conducting material connecting with the main circuit and adapted to be put in contact with said terminals and move about the surface of the switchboard while always making sliding contact with the terminals directly beneath the figure or character.

572,162. MAGNETIC SEPARATOR; J. B. Hamilton, Springfield, Mass. App. filed Dec. 5, 1893. In a magnetic separator, the combination with an electromagnetic roll or cylinder, of a wiper adapted to be held in contact with said roll or cylinder by magnetic attraction, and means for imparting movement to said wiper longitudinally of the roll or cylinder.

572,169. ELECTRICALLY-ACTUATED RAILWAY SWITCH; R. M. Hunter, Philadelphia, Pa. App. filed July 25, 1894. The combination of a branching railway having positive suspended conductors, a track switch at the juncture of the two railways, electric power devices for throwing the switch in either direction, two downwardly-extending loosely-swinging contacts arranged at a distance in advance of the track-switch and movable on transverse axes on each side of the suspended conductor, electric circuits between the contacts and respective power devices, an electrically-propelled car having an upwardly-extending underrunning trolley device extending upward so as to pass freely between the swinging contacts and making contact with the suspended conductor, and provided with laterally projecting pins or contact devices for closing an electric circuit with either of the first-mentioned pivoted contacts by striking and then moving under them, and a switch device on the car for putting either of the laterally-projecting contacts on the car into electric circuit with the motor circuit of the car.

572,182. TELEPHONE TRANSMITTER; F. A. Ray, Boston, Mass. App. filed Oct. 23, 1895. The combination with a sound-receiving diaphragm, a thin carbon disc affixed on one side thereof, and an apertured damper-disc to cover the remaining side surface of the diaphragm, of an exterior casing, a fixed electrode therein, an exterior retaining ring, a felted damper ring circumferentially between the retaining ring and the diaphragm, and a cell to contain finely-granulated material as a variable resistance.

572,188. TELEPHONE TRANSMITTER; L. D. Appleman, Waynesborough, Va. App. filed March 19, 1896. In a telephone transmitter, the combination with a diaphragm, a fixed electrode and an electrode attached to said diaphragm and an interposed granular conducting mass, of means operated by said diaphragm for causing the entire surface of the electrode attached thereto to move away from the granular mass during the vibration of the diaphragm from the speaker and to approach the same during the vibration of diaphragm toward the speaker.

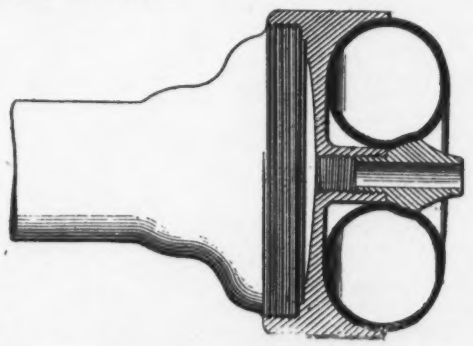
572,198. ACCUMULATOR OR SECONDARY BATTERY; F. W. Ellermann, Vienna, Austria-Hungary. App. filed Dec. 16, 1895. A composition for manufacturing accumulator plates, consisting of litharge and sugar of magnesium mixed into a plastic mass with liquid ammonia.

572,215. INSULATED ELECTRIC CONDUCTOR; W. R. Patterson, Chicago, Ill. App. filed Dec. 10, 1894. As a new article of manufacture an electric conductor immediately surrounded by a layer of wool, and a cotton covering formed directly upon said layer of wool, said cotton covering being impregnated with a fireproofing compound, to thereby produce a non-inflammable insulation possessing high non-hygroscopic properties.

572,218. NEEDLE PLUG TEST SYSTEM FOR MULTIPLE SWITCHBOARD; C. E. Scribner, Chicago, Ill. App. filed June 1, 1888. The combination with a telephone line connected to earth at a sub-station and with spring-jack switches, one on each of two or more multiple switchboards and from the switch on the last board through a grounding-jack and battery to ground, of the terminal plug of said line inserted in said grounding-jack to close the connection of the line with said battery, a switching device including one winding of an induction coil, and the main contacts of a rheotome or vibrator, which switching device, on being inserted in a spring-jack of the line loops said winding of the induction coil and rheotome into the circuit and a telephone connected in a circuit with the other winding of the induction coil.

572,219. CORD SWITCH FOR TELEPHONE SWITCHBOARDS; C. E. Scribner, Chicago, Ill. App. filed May 14, 1894. In combination a socket and a resting plug resting therein, a lever of the first-class having one extremity bearing upon the side of said plug, switch contacts actuated by the other extremity of said lever, and circuit connections with the switch-contacts.

572,220. ELECTRIC SIGNAL BELL; C. E. Scribner, Chicago, Ill. App. filed May 31, 1894. The combination with an electromagnet, of a pivoted armature therefor, adapted to oscillate to and from the magnet-poles, two pairs of contact points controlled thereby to be simultaneously closed together at a point of the oscillation of the armature intermediate between the extremities of its range, and an electric circuit including the said contact-points in series.



No. 572,108.—EAR-PIECE FOR TELEPHONE RECEIVERS.

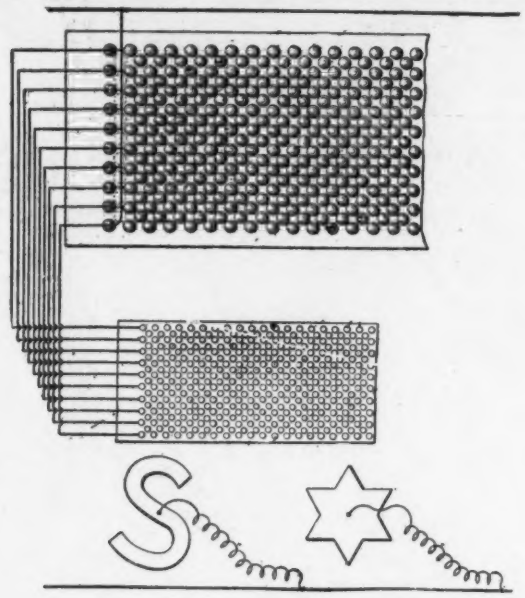
572,221. TELEPHONE EXCHANGE SYSTEM. C. E. Scribner, Chicago, Ill. App. filed Oct. 16, 1894. The combination with the telephone lines of a group, each provided with means for making connection with it in a switchboard, a relay in each line normally responsive to the currents in the line, a local circuit containing an operator's telephone adapted for connection with any of the lines through the agency of the corresponding relay, a device actuated in the movement of any relay adapted to prevent the operation of any other relay at the same time, and mechanism actuated in making connection with the line, adapted to restore the said device to its normal position to permit the subsequent operation of other relays.

572,222. TELEPHONE CIRCUIT; C. E. Scribner, Chicago, Ill. App. filed Aug. 1, 1895. The combination in an electric circuit, of a source of current, a valuable resistance transmitting telephone, an inductive resistance in shunt of the telephone and an electromagnetic responsive instrument requiring for its operation a current greater than the maximum resistance of the transmitter would permit.

572,223. APPARATUS FOR TELEPHONE SWITCHBOARDS; C. E. Scribner, Chicage, and F. R. McBerty, Downer's Grove, Ill. App. filed June 6, 1894. The combination with a telephone line of an operator's telephone connected therewith, a plug connected with the line for uniting it with another line by means of a spring jack thereof, a relay controlling switch,

contacts included in the circuit of the telephone and a local circuit containing the magnet of the said relay, terminating in registering contact points of the said plug and spring jack, whereby the operator's telephone is connected with the line until the plug is inserted in the said jack and is reconnected with the line when the plug is removed from the spring-jack.

572,268. RAILWAY SIGNAL APPARATUS; B. B. Morgan, Ypsilanti, Mich. App. filed May 15, 1894. In a track signal device, the combination of a track consisting of two rails, a spring rail in connection with each rail thereof, both adjacent but successive one to the other, block connections adapted to be operated by the spring rails respectively, connections between the blocks arranged in such manner that the depression of one block on one side operates to withdraw the other block from operative contact with the opposite spring-rail, and means to hold it in an inoperative position.



No. 572,158.—Electric Sign.

572,285. BATTERY CELL; C. Willms, Baltimore, Md. App. filed Aug. 15, 1896. A battery cell or vessel having a seal or stopper of caoutchouc vulcanized to it.

572,319. ELECTRIC SWITCH; C. B. Sterling, New York, N. Y. App. filed June 13, 1895. In an electrical switch, a rotatable stem provided with a handle, a carrier plate loosely carried by the rotatable stem, a yielding connection between the said plate and stem, said carrier plate provided with contacts, and two or more of said contacts being connected with each other by a conductor at the under side of the plate, in combination with fixed contacts connected with electrical conductors and overhanging the carrier plate, all of said fixed contacts being in the path of all the carried contacts.

572,341. ELECTRIC ROLLER FOR THERAPEUTICAL AND MASSAGE PURPOSES; J. W. Gibbs, New York, N. Y. App. filed Sept. 22, 1896. An electric roller consisting of a central body and superimposed generating plates, as copper and zinc.

572,353. AMALGAMATOR; W. L. and C. Brown, San Francisco, Cal. App. filed Feb. 27, 1895. In an amalgamator, a tank or receptacle having curved sides and amalgamating plates fitted thereto, a pipe extending along the bottom between the sides with openings so disposed as to direct a fluid discharge therefrom against the concave surface of the amalgamating plates, and an exhausting and discharging device having its discharge connected with said pipe and its exhaust connected with the interior of the tank near the top below the surface of its contents, whereby a continuous circulation is maintained.

572,354. ELECTRIC LAMP POST; J. Buckner, Boston, Mass. App. filed Dec. 26, 1895. An improved insulating lamp post, comprising a tubular metallic base section having a tapered socket and an elongated wooden section having a metallic lamp holder at its upper end and a tapered shank at its lower end, of greater length than the said socket, being supported with an unobstructed space below the tapered shank, whereby the said tapered shank and socket may automatically compensate for shrinkage of the wooden section and maintain a firm connection between the two, and a collar surrounding the meeting points of the two sections at the top of the base-section, said collar being secured to one of said sections and adapted to move vertically on the other section.

572,369. MAGNETIC ORE SEPARATOR; C. J. Reed, Orange, N. J. App. filed Sept. 3, 1891. An ore separator having one or more magnets inside of a hollow cylinder or chamber, in combination with a second surrounding hollow cylinder or chamber through which the ore is advanced longitudinally in one direction, while the tailings are discharged in another direction.

572,370. MECHANISM FOR SEPARATING MAGNETIC FROM NON-MAGNETIC SUBSTANCES; C. J. Reed, Orange, N. J. App. filed Dec. 30, 1891. A machine for separating magnetic from non-magnetic substances, a hollow revolving drum in combination with fixed or stationary external magnets and means consisting of a tube and a feed regulating device for regulating the flow of the material into the interior of the drum.

572,377. ELECTRIC TOWING APPARATUS; A. E. Schatz, New York, N. Y. App. filed Jan. 19, 1893. In combination with a boat, of a carriage movable along a suitable support adjacent to a water way, an electrical propelling motor on said carriage circuit connections, means for connecting the carriage and boat, whereby the latter will be propelled by the former, and connections, including a switch between the motor and the boat, whereby the motor current may be controlled by a person on board the boat.

572,378. ANNUNCIATOR DROP; W. Schwagerman, Yonkers, N. Y. App. filed Feb. 24, 1896. In an annunciator, a magnet, a drop having an opening therein, and an armature located at each side of the magnet and normally held out of contact with the same, said armatures being each provided with a head adapted to enter the opening of the drop and support the same.

572,380. VOLTMETER; A. A. Simonds, Dayton, O. App. filed March 20, 1896. The combination with a voltmeter comprising among its members a coil of electrical conducting material and indicating mechanism operated thereby, of means for regulating the temperature of said conducting material to maintain the uniform conductivity thereof, and secure uniform action of said indicating mechanism.

572,421. REGULATOR FOR INCANDESCENT LAMPS; W. Hawker, Montreal, Canada. App. filed May 29, 1896. A current-regulator for electric lamps and other devices, comprising pairs of resistance coils, the resistance of one pair of coils being greater than that of another pair of coils, connections between the several coils, conductors adapted for engagement with the main lead wires, a contact plate for each of the coils and having connection therewith, lamp circuit plates, and a sliding contact-block adapted for engagement with said lamp circuit plates and with pairs of plates connected with the resistance-coils.

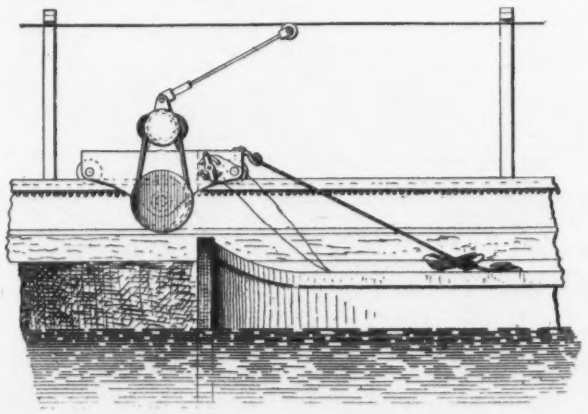
572,430. ELECTRIC LIGHTING MECHANISM FOR BICYCLES; F. E. Magee, Brooklyn, N. Y. App. filed March 25, 1896. A generator for an electric-light current, comprising a multiple-coil armature, a collector ring on the armature shaft, lead-wires extending from the coils to the collector ring, a lead-wire extended from one of the coils to the shaft, a lead-wire extended from the other of said coils to a resilient arc carried by the shaft, and having a weighted end normally in engagement with the shaft, and connections for carrying a current from the collector ring and shaft to a lamp.

572,431. ELECTRIC LAMP; F. E. Magee, Brooklyn, N. Y. App. filed March 25, 1896. An electric lamp comprising a metal casing, a lens in its forward end, a reflector adjustable longitudinally in the casing, an incandescent lamp-socket carried by the reflector, means for causing the adjustments of the reflector, and means for carrying an electric current to the lamp in the socket.

572,438. CELL OR BOX FOR ELECTRIC BATTERIES; J. M. Moffat, London, England. App. filed May 23, 1896. A battery cell or box provided with an inwardly turned or curled lip at its upper end, a sealing lid beneath said lip, and a vent arranged in said sealing lid and opening beneath said lip, thereby preventing the escape of liquid while permitting the escape of gas from said cell or box.

572,467. ELECTRIC HEATER; B. E. Baker, New Britain, Conn. App. filed June 4, 1894. The combination with a shell having lugs, ledges and stumps, of a resistance block and wire within the shell, screws to which the ends of the resistance wire are connected, a closing-plate resting on the ledges and the stumps, the said screws passing through the closing-plate, a top-plate resting on the lugs and having a recess in its under side, a non-conducting packing in said recess and insulated screws which pass through the top plate, the packing and the closing-plate and engage the stumps.

572,507. CURRENT CONTROLLING DEVICE; J. J. Hogan, New Haven, Conn. App. filed July 24, 1896. An apparatus for taking off specific low-voltage currents of measured quantity from large currents of high potential, consisting of a suitable base-board, connecting-plug, fuse-receptacle and safety fuse, a snap switch, a plurality of incandescent lamps in multiple arc, a plurality of resistance coils, a series of contact-buttons in graduated circuit with said resistance coils, a radial switch arc contacting with said buttons and binding posts.



No. 572,377.—Electric Towing Apparatus.

572,510. METHOD OF AND APPARATUS FOR TRANSPORTING ELECTRIC CURRENTS; M. Hutin and M. Leblanc, Paris, France. App. filed Nov. 4, 1892. The method of converting alternating electric currents into currents of one direction, or *vice versa*, by dynamic induction, which consists in carrying the coefficient of mutual induction of the circuits of a transformer or transformers in accordance with the law of variation of the alternating-currents] received or delivered by the said transformer or transformers.